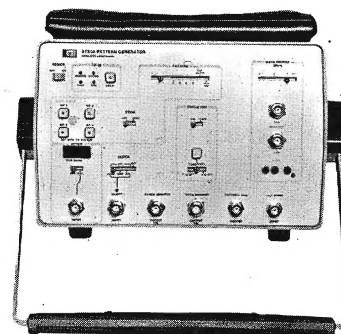
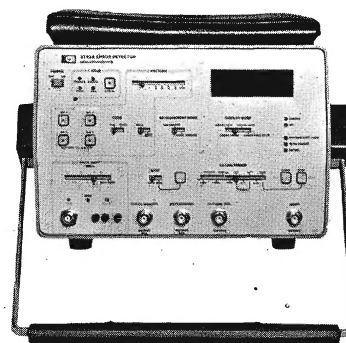


# OPERATING MANUAL

## 3781A PATTERN GENERATOR



## 3782A ERROR DETECTOR



HEWLETT  
PACKARD

## **CERTIFICATION**

*Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.*

## **WARRANTY**

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

### **LIMITATION OF WARRANTY**

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

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THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

## **ASSISTANCE**

*Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.*

*For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.*



**HEWLETT  
PACKARD**

## **OPERATING MANUAL**

# **3781A PATTERN GENERATOR and 3782 A ERROR DETECTOR (Including Options 001,002,061 and 062)**

### **SERIAL NUMBERS**

This manual applies directly to instruments with serial numbers prefixed 2109U.

For additional important information about serial numbers see INSTRUMENTS COVERED BY MANUAL in Section I.

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SOUTH QUEENSFERRY, WEST LOTHIAN, SCOTLAND

Manual Part Number: 03781-90010  
Microfiche Part Number: 03781-90035

Printed: April 1981


## WARNING

*READ THE FOLLOWING NOTES BEFORE INSTALLING OR SERVICING THE INSTRUMENT.*

1. IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTO-TRANSFORMER MAKE SURE THAT THE COMMON TERMINAL OF THE AUTO-TRANSFORMER IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.
2. THE INSTRUMENT MUST ONLY BE USED WITH THE MAINS CABLE PROVIDED. IF THIS IS NOT SUITABLE, CONTACT YOUR NEAREST HP SERVICE OFFICE. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).
3. THE SERVICE INFORMATION FOUND IN THIS MANUAL IS OFTEN USED WITH POWER SUPPLIED TO AND PROTECTIVE COVERS REMOVED FROM THE INSTRUMENT. ENERGY AVAILABLE AT MANY POINTS MAY, IF CONTACTED, RESULT IN PERSONAL INJURY.
4. BEFORE SWITCHING ON THIS INSTRUMENT:
  - (a) Make sure the instrument input voltage selector is set to the voltage of the power source.
  - (b) Ensure that all devices connected to this instrument are connected to the protective (earth) ground.
  - (c) Ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient).
  - (d) Check that the instrument fuse(s) is of the correct type and rating.
5. SERVICING INFORMATION:
  - (a) This manual contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in safe condition. Service and adjustments should be performed only by qualified service personnel.
  - (b) Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.
  - (c) Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.
  - (d) Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.





## LIST OF CONTENTS

SECTION I  
GENERAL INFORMATION

Paragraph		Page
1-1	INTRODUCTION .....	1-1
1-5	SPECIFICATIONS .....	1-1
1-7	SAFETY CONSIDERATIONS .....	1-1
1-10	INSTRUMENTS COVERED BY MANUAL .....	1-1
1-15	DESCRIPTION .....	1-2
1-21	Binary Errors .....	1-2
1-23	Code Errors .....	1-2
1-26	Jitter Modulation .....	1-3
1-29	PRBS Zero Substitution .....	1-3
1-31	Programmability .....	1-3
1-33	HEWLETT-PACKARD INTERFACE BUS (HP-IB)  .....	1-3
1-34	Compatibility .....	1-3
1-38	Selecting the HP-IB Address .....	1-4
1-40	HP-IB Controllers .....	1-4
1-42	Printer .....	1-4
1-44	Real-Time Clock .....	1-4
1-46	DEFINITION OF TERMS .....	1-4
1-48	AMI .....	1-4
1-50	BER .....	1-4
1-52	Binary Data .....	1-4
1-54	RZ .....	1-4
1-56	NRZ .....	1-4
1-58	Bi-polar Violations .....	1-5
1-60	Codes .....	1-5
1-62	HDB3 .....	1-5
1-64	Delayed Data .....	1-5
1-66	Error Add .....	1-5
1-69	PRBS .....	1-5
1-71	Recovered Clock .....	1-5
1-73	Ternary Data .....	1-5
1-75	Word .....	1-6
1-77	Synchronization .....	1-6
1-79	Zero Substitution .....	1-6
1-81	OPTIONS .....	1-6
1-89	ACCESSORIES SUPPLIED .....	1-6
1-91	ELECTRICAL EQUIPMENT AVAILABLE .....	1-6
Figure		
1-1	3781A Pattern Generator and 3782A Error Detector .....	1-0
1-2	Serial Number Plate .....	1-1
1-3	Binary Errors .....	1-2
1-4	Code Errors .....	1-3

	1-5	AMI Data/Clock . . . . .	Page 1-4
	1-6	RZ Data/Clock . . . . .	1-4
	1-7	NRZ Data/Clock . . . . .	1-5
	1-8	Bi-polar Violation . . . . .	1-5
	1-9	HDB3 Data . . . . .	1-5
	1-10	Zero Substitution . . . . .	1-6
Table	1-1	Specifications . . . . .	1-7

## SECTION II INSTALLATION

Paragraph	2-1	INTRODUCTION . . . . .	Page 2-1
	2-3	INITIAL INSPECTION . . . . .	2-1
	2-5	PREPARATION FOR USE . . . . .	2-1
	2-6	Power Requirements  . . . . .	2-1
	2-8	Line Voltage Selection  . . . . .	2-1
	2-10	Power Cord . . . . .	2-2
	2-12	HP-IB Address Selection  . . . . .	2-3
	2-15	Interconnections . . . . .	2-3
	2-17	Mating Connectors . . . . .	2-3
	2-20	Operating Environment . . . . .	2-5
	2-22	RACK MOUNTING . . . . .	2-5
	2-25	STORAGE AND SHIPMENT . . . . .	2-7
	2-26	Environment . . . . .	2-7
	2-28	Repackaging for Shipment . . . . .	2-7
Figure	2-1	Line Voltage Selection . . . . .	2-1
	2-2	Power Cable and Mains Plug Part Numbers . . . . .	2-2
	2-3	HP-IB Address Switches . . . . .	2-3
	2-4	Hewlett-Packard Interface Bus Connection . . . . .	2-3
	2-5	Rack Mounting . . . . .	2-5
Table	2-1	Fuses . . . . .	2-2
	2-2	Allowable HP-IB Address Codes  . . . . .	2-4

## SECTION III OPERATION

Paragraph	3-1	INTRODUCTION . . . . .	Page 3-1
	3-4	POWER CONTROLS AND CONNECTORS . . . . .	3-1
	3-7	3781A Pattern Generator CONTROLS, CONNECTORS AND INDICATORS . . . . .	3-2
	3-8	Front-Panel Description . . . . .	3-2
	3-9	Rear-Panel Description . . . . .	3-3
	3-10	3782A Error Detector CONTROLS, CONNECTORS AND INDICATORS . . . . .	3-3



	3-11	Front-Panel Description .....	Page 3-3
	3-12	Rear-Panel Description .....	3-5
	3-13	SWITCH-ON PROCEDURE .....	3-6
	3-16	HP-IB MODES OF OPERATION .....	3-6
	3-18	Operation in the Talk Only Mode (3782A only) .....	3-6
	3-20	Operation in the Addressable Mode .....	3-6
	3-24	PRINCIPAL FEATURES OF HP-IB OPERATION .....	3-6
	3-25	IMPLEMENTATION OF HP-IB .....	3-7
	3-26	REPertoire OF REMOTE COMMANDS .....	3-7
	3-31	CONTROLLING MASKS .....	3-9
	3-33	RESULT PRINT THRESHOLD SWITCH (3782A only) .....	3-12
	3-35	REPertoire OF MESSAGES (3782A only) .....	3-12
	3-37	TERMINATION OF A BUFFER (3782A only) .....	3-13
	3-39	SERVICE REQUESTS .....	3-13
	3-42	REPertoire OF SERVICE REQUESTS .....	3-13
	3-44	LOCAL Push-button .....	3-14
	3-46	Internal Real-Time Clock (3782A only) .....	3-14
	3-50	USING THE HP 37201A BUS EXTENDER .....	3-14
	3-52	DEFINITION OF 'LEARN' TRANSFER .....	3-14
	3-55	OPERATORS CHECKS .....	3-15
	3-57	BASIC FUNCTIONAL CHECKS .....	3-15
	3-58	ERROR CODES (3782A only) .....	3-17
	3-60	OPERATORS MAINTENANCE .....	3-17
	3-62	Fuses  .....	3-17
	3-64	Air Filter  .....	3-17
Figure	3-1	Key to Front-Panel Controls, Connectors and Indicators .....	3-2
	3-2	Slide Switch Position Numbering .....	3-7
Table	3-1	3781A Switch Mnemonics .....	3-7
	3-2	3782A Switch Mnemonics .....	3-8
	3-3	Bit Significance .....	3-9
	3-4	3781A Mask Default Values .....	3-10
	3-5	3782A Mask Default Values .....	3-10
	3-6	Result-Print Threshold .....	3-12
	3-7	Output Messages .....	3-12
	3-8	3781A Service Request Codes .....	3-13
	3-9	3782A Service Request Codes .....	3-13
	3-10	3781A Response Codes .....	3-14
	3-11	3782A Response Codes .....	3-14
	3-12	Display Readings .....	3-15
	3-13	ZERO SUB Settings .....	3-16
	3-14	ZERO SUB Settings .....	3-16
	3-15	Error Code Description .....	3-17



Figure 1-1 3781A Pattern Generator and 3782A Error Detector



## SECTION I

### GENERAL INFORMATION

#### 1-1 INTRODUCTION

1-2 This Operating Manual contains information required to install, check and operate the Hewlett-Packard Models 3781A Pattern Generator and 3782A Error Detector. Figure 1-1 shows the 3781A, 3782A and accessories supplied.

1-3 Supplied with the instruments are separate Service Manuals – for use by the maintenance engineer. This Operating Manual should be kept with the instrument for use by the operator. Additional copies of 3781A/3782A publications may be ordered through your nearest Hewlett-Packard Office.

1-4 On the title page of this manual, below the manual part number, is a Microfiche part number. This number can be used to order this manual in 4 x 6-inch microfilm transparencies, each transparency contains up to 96 photoduplicates of the manual pages. The Microfiche package also includes the latest Manual Changes supplement as well as all pertinent Service Notes.

#### 1-5 SPECIFICATIONS

1-6 Instrument specifications are listed in Table 1-1. These specifications are performance standards or limits, against which the instrument is tested.

#### 1-7 SAFETY CONSIDERATIONS

1-8 The HP Models 3781A Pattern Generator and 3782A Error Detector are Safety Class 1 (IEC) instruments. These instruments have been designed according to international safety standards. The instruments and manuals should be reviewed for safety markings and instructions before operation.

1-9 This manual contains information, cautions and warnings which must be followed by the user to ensure safe operation and retain the instruments in a safe condition.



**Refer to Service Manual:** This symbol on the instrument means the user must refer to the instrument's Service Manual to protect the instrument from damage.



**Protective Earth Ground:** Indicates protective earth ground terminal of the ac power source or the instrument. All exposed metal surfaces on the instrument *must* connect to a protective earth ground terminal.



**Frame or Chassis Terminal:** This symbol identifies a terminal that is normally common to all exposed metal surfaces on the instrument.

#### WARNING

The **WARNING** sign denotes a hazard to the operator. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

#### CAUTION

The **CAUTION** sign denotes a hazard to the instrument. It calls attention to an operating or maintenance procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the instrument. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

#### 1-10 INSTRUMENTS COVERED BY MANUAL

1-11 Attached to the rear-panel of the instrument is a serial number plate. The serial number plate has a four-digit serial prefix, a reference letter denoting country of origin (U = United Kingdom) and a five-digit serial number. The serial prefix is the same for all identical instruments, it changes only when a change is made to the instrument. The serial number is unique to each instrument.

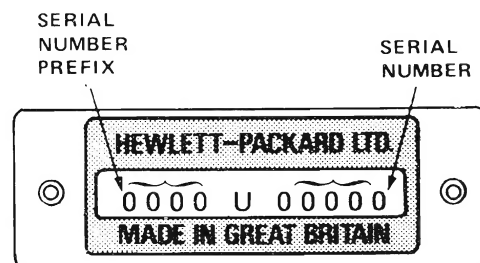


Figure 1-2 Serial Number Plate

1-12 The contents of this manual apply directly to all instruments with a serial number prefix listed under SERIAL NUMBERS on the title page. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the instrument is different from those described in this manual. The Service Manuals for these instruments are supplied with a blue Manual Changes supplement, which contains the change information that documents the differences and explains how to adapt these manuals to the newer instruments.

1-13 In addition to change information, the Manual Changes supplement may contain information for correcting errors in the manuals. To keep this manual as current and as accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement — quoting this manual's print date and part number (both of which appear on the title page). Complementary copies of the supplement are available from Hewlett-Packard.

1-14 For information concerning a serial number prefix which is not listed on the title page or in a Manual Changes supplement, contact your nearest Hewlett-Packard Office.

## 1-15 DESCRIPTION

1-16 The HP Models 3781A Pattern Generator and 3782A Error Detector comprise an error performance measurement system dedicated to the testing and evaluation of digital transmission terminal and link equipment up to and including the third level (34368kb/s) in the CEPT digital hierarchy.

1-17 Both instruments are microprocessor based and HP-IB\* compatible thus allowing operational simplicity and measurement flexibility. (\*HP-IB — Hewlett-Packard Interface Bus — is Hewlett-Packard's implementation of IEEE Standard 488-1978.)

1-18 The 3781A and 3782A operate at bit rates of 704, 2048, 8448 and 34368kb/s in the digital hierarchy. The 3781A also contains jitter modulation as a standard feature.

1-19 In addition, the instruments can operate at any bit rate in the range 1kb/s to 50Mb/s using external clock and, binary clock and data interfaces in TTL format.

1-20 The 3782A measures binary errors and code errors — displayed as error rate (sometimes referred to as error ratio), error count, error seconds and error free seconds in a digital transmission system.

## 1-21 Binary Errors

1-22 The 3781A transmits a digital pattern at the selected rate with the desired ternary coding (AMI or HDB3). The appropriate interface voltage levels are automatically applied when the required bit rate is selected. Simultaneously, the 3782A compares the output from the system under test with a separate internally-generated error-free pattern (identical to the 3781A pattern). This comparison is made at the binary level after decoding and pattern synchronization have been removed. Differences between the two patterns are counted over a selected gating period and displayed in one of four modes — error rate (error ratio), error count, error seconds or error free seconds. (Figure 1-3 shows binary error detection.)

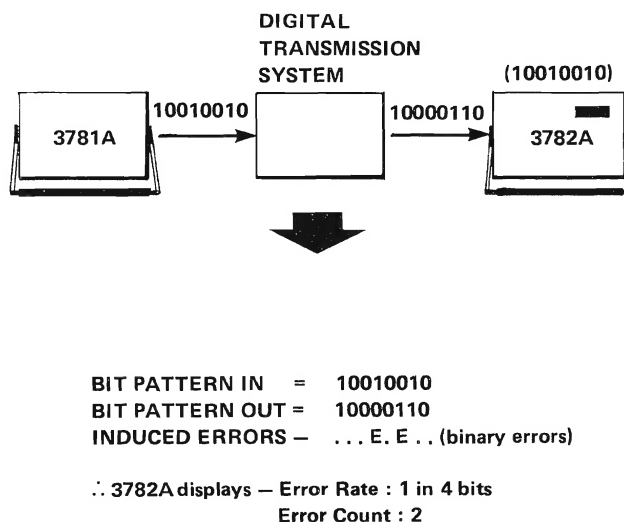


Figure 1-3 Binary Errors

## 1-23 Code Errors

1-24 The 3782A monitors interface or line-coded information for code errors. These errors are detected during decoding into binary data and counted and displayed in the same way as binary errors.

1-25 Binary information is nearly always coded before it reaches the digital transmission line.

The 3782A detects violations in the following manner:

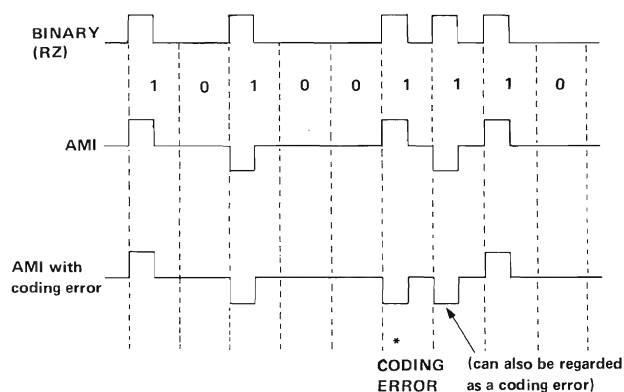


Figure 1-4 Code Errors

Figure 1-4 shows that code errors may not be an accurate measure of the error performance of a digital transmission system.

### 1-26 Jitter Modulation

1-27 The 3781A has the built-in facility of applying a controlled amount of jitter to the output bit stream (using a simple external modulating signal source). This is displayed as jitter amplitude (in bits peak-to-peak) on a 4-digit LED display which flashes when the jitter is out-of-range. The frequency and amplitude of jitter depends on the frequency and amplitude respectively of the modulating signal. The resultant effect of the jittered data stream on the transmission system can be measured by the 3782A in terms of error performance.

1-28 This feature is particularly useful in simulating real traffic conditions since jitter tends to accumulate as a function of the length of a digital link due to the action of digital regenerators. Jitter impairments also become more noticeable as the bit rate increases. The jitter modulation facility thus allows the jitter tolerance of PCM equipment to be tested.

### 1-29 PRBS Zero Substitution

1-30 This allows the PRBS to be gated off for a number of clock periods determined by the setting of the ZERO SUB push-buttons. Gating occurs every sequence following the PRBS trigger pulse. By measuring the error performance, using PRBS patterns with zero substitution, the pattern sensitive parts of a system can be examined — for example, regenerator clock recovery circuits.

## 1-31 Programmability

1-32 The Pattern Generator and Error Detector are completely programmable via the Hewlett-Packard Interface Bus (HP-IB). This, coupled with the diversity of measurements the Pattern Generator/Error Detector combination can make, makes the instruments ideal for 'systems' applications.

## 1-33 HEWLETT-PACKARD INTERFACE BUS (HP-IB)



## 1-34 Compatibility

1-35 The extent to which the instruments are compatible with the HP-IB is given by the following list of interface functions:

Pattern Generator: SH1, AH1, T6, L4, SR1, RL1, DC1  
Error Detector: SH1, AH1, T5, L4, SR1, RL1, DC1

1-36 The instruments interface with the HP-IB via open-collector TTL circuitry. An explanation of the implementation code may be found in IEEE Standard 488 "IEEE Standard and Digital Interface for Programmable Instrumentation", or the identical ANSI Standard MC1.1.

1-37 For more detailed information relating to programmable control of these instruments, refer to HP-IB MODES OF OPERATION (Paragraph 3-16).

## 1-38 Selecting the HP-IB Address

1-39 The HP-IB ADDRESS switches are located on the rear-panels of the 3781A and 3782A. The switches represent a five-digit binary number. This number represents the talk and listen address characters which an HP-IB Controller can generate. Table 2-2 (in Section II) shows all HP-IB talk and listen addresses. Also refer to HP-IB ADDRESS SELECTION (Paragraph 2-12).

## 1-40 HP-IB Controllers

1-41 The HP-IB interface enables the 3781A and 3782A to be used with any HP-IB compatible Computing Controller or Computer for automatic 'systems' applications.

## 1-42 Printer

1-43 An HP-IB compatible Printer may be connected to the 3782A for either the 'Talk Only' or 'Addressable' modes.

## 1-44 Real-Time Clock

1-45 The 3782A has a built-in, crystal-controlled, real-time clock. This permits peripheral devices to receive timed messages from the 3782A.

## 1-46 DEFINITION OF TERMS

1-47 The following paragraphs give brief definitions of terms which relate to the functions of the instrument and are commonly used in this manual.

## 1-48 AMI

1-49 Alternate Mark Inversion (often called “bi-polar” coding) is a form of ternary data in which data “marks” (normally representing ‘1’s) are alternatively positive and negative. The main advantages of this basic code are that the average dc potential on the line is zero and, that this code can be used to detect if one data bit has been changed during transmission (as two consecutive bits would then have the same polarity). (See Figure 1-5.)

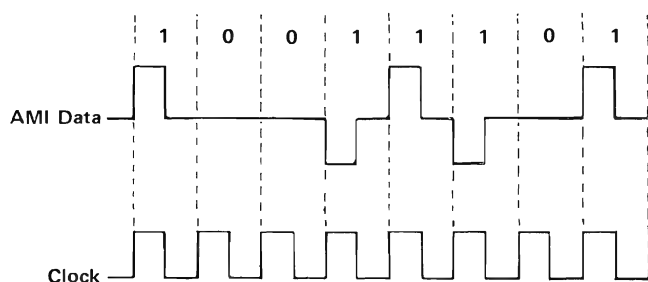


Figure 1-5 AMI Data/Clock

## 1-50 BER

1-51 Bit Error Rate (or Bit Error Ratio) is the ratio of the number of errors detected to the total number of clock periods measured over a selected gating period.

## 1-52 Binary Data

1-53 Data ‘ones’ and ‘zeros’ are represented by a two-level signal (see RZ and NRZ).

## 1-54 RZ

1-55 Return-to-Zero data is at the ‘one’ level for the duration of the clock mark and returns to ‘zero’ for the duration

of the clock space. This is the format used for ternary data interface in the 3781A/3782A. (See Figure 1-6).

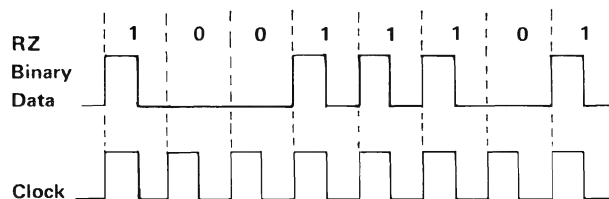


Figure 1-6 RZ Data/Clock

## 1-56 NRZ

1-57 Non-Return-to-Zero data remains at the ‘one’ level for the whole clock period. The data level is continuous between consecutive ‘ones’. This is the format used for binary data interfaces in the 3781A/3782A (See Figure 1-7.)

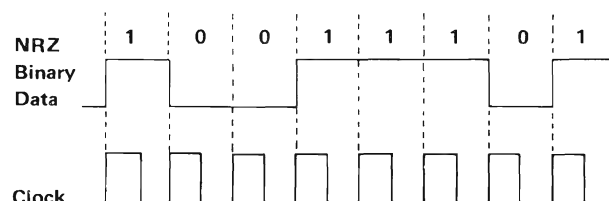


Figure 1-7 NRZ Data/Clock

## 1-58 Bi-polar Violations

1-59 Bi-polar violations are violations of the AMI coding rule in which two consecutive marks have the same polarity. A bi-polar violation is normally designated ‘V’. (See Figure 1-8).

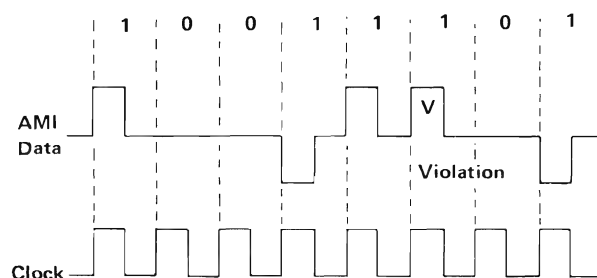


Figure 1-8 Bi-polar Violation

## 1-60 Codes

1-61 Refinements of the AMI code in which long sequences of zeros are eliminated by substituting a fixed pattern for the sequence of zeros. The substitution allows the clock signal to be more easily recovered from the data when long runs of zeros occur. The codes referred to in this manual are AMI and HDB3.

## 1-62 HDB3

1-63 High Density Bipolar 3 (HDB3) is a code in which a pattern is substituted for each block of four consecutive zeros in the data stream. The substitution contains a bipolar violation which can be recognised at the receive terminal decoder and the substitution removed. (See Figure 1-9.)

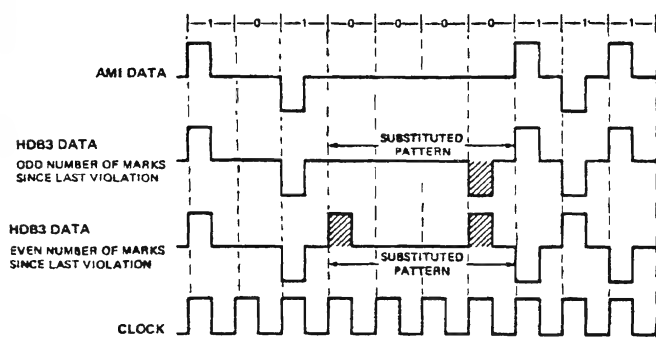


Figure 1-9 HDB3 Data

## 1-64 Delayed Data

1-65 As applied to these instruments, delayed data is data which is delayed by 12 bits from normal data.

## 1-66 Error Add

1-67 Binary data bits changed to produce an error without increasing the sequence length. The errors introduced take the form of the complement of 1 data bit in each  $10^3$  bits,  $10^5$  bits or single-shot errors.

1-68 Coded data bits are changed to produce a code error without increasing the sequence length or the binary error rate. The errors introduced take the form of a positive mark changed to a negative mark or vice-versa. This results in code errors. The 3782A measures code errors as defined below:

- AMI — two consecutive marks of the same polarity i.e., a bi-polar violation ("V").
- HDB3 — "violation of violations" i.e., two consecutive bipolar violations with same polarity.

## 1-69 PRBS

1-70 A PRBS (Pseudo Random Binary Sequence) is a repetitive sequence  $2^n - 1$  bits long generated by an n-stage shift register with modula-two gating. For example, a 9-stage shift register produces a sequence  $2^9 - 1$  (or 511) bits long.

## 1-71 Recovered Clock

1-72 The Error Detector clock signal is recovered from the ternary input data.

## 1-73 Ternary Data

1-74 "One" and "zero" are represented by a three-level signal. Ternary data is a general term which includes AMI and the codes described in this section. All of these are more correctly described as "pseudo-ternary" codes, as positive and negative marks mean the same thing.

## 1-75 Word

1-76 A repetitive fixed sequence.

## 1-77 Synchronization

1-78 In order to function correctly, the 3782A Error Detector must have:

- bit synchronization — recovered clock from input data or correctly phased external clock and binary data.
- pattern synchronization — the reference pattern must be in phase with the input data pattern.

## 1-79 Zero Substitution

1-80 Zeros are substituted for part of the PRBS without increasing the sequence length. The zeros overwrite a section of the pattern. (See Figure 1-10.)

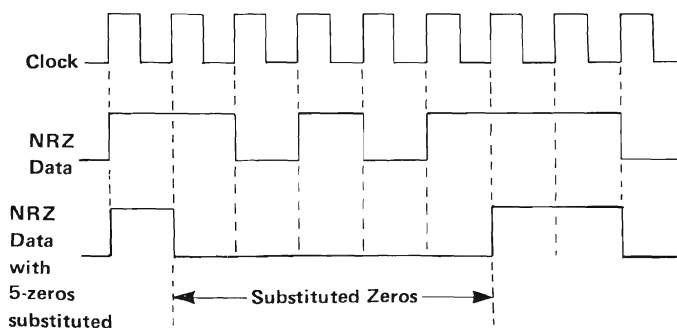


Figure 1-10 Zero Substitution

## 1-81 OPTIONS

1-82 **Option 001** (3781A Only) provides four additional 1V pk outputs coded in HDB3, via 75 $\Omega$  BNC connectors, on the rear panel.

1-83 **Option 002** (3781A Only) — as standard but with small Siemens 75 $\Omega$  connectors (1.6mm/5.6mm) replacing BNC connectors on CLOCK INPUT, CLOCK MONITOR OUTPUT, DATA MONITOR OUTPUT, DATA OUTPUT and DELAYED DATA OUTPUT.

1-84 **Option 002** (3782A Only) — as standard but with small Siemens 75 $\Omega$  connectors (1.6mm/5.6mm) replacing BNC connectors on DATA INPUT and all rear-panel connectors except EXT GATING INPUT.

1-85 **Option 061** Rack-mounted 3781A or 3782A.

1-86 **Option 062** Rack Mount enables front-panel control of some rear-panel switches and inputs/outputs.

3781A Option 062 enables the four rear-panel HDB3 OUTPUTS (Option 001) to be accessed from the front panel.

3782A Option 062 enables the rear-panel BINARY/TERNARY and REAL-TIME CLOCK switches and the BINARY CLOCK, BINARY DATA and EXTERNAL GATING INPUTs to be accessed from the front panel.

1-87 **Option 910** extra set of manuals.

1-88 The In-Lid Instructions are available in several European languages. If no option number is quoted, the English version will be supplied.

- Option 031 — German language version.
- Option 032 — French language version.
- Option 033 — Italian language version.
- Option 034 — Spanish language version.

## 1-89 ACCESSORIES SUPPLIED

1-90 Figure 1-1 shows the HP Models 3781A, 3782A and the accessories supplied. The accessories supplied comprise:

- Storage Covers (which house In-lid Instructions)
- Power Cables
- Extender Boards (one per instrument)

## 1-91 ELECTRICAL EQUIPMENT AVAILABLE

### 1-92 HP-IB Controllers

1-93 The 3781A Pattern Generator and 3782A Error Detector have an HP-IB interface and can be used with any HP-IB Computing Controller or Computer for automatic 'systems' applications.

### 1-94 Printer

1-95 An HP-IB compatible Printer (eg., HP Model 5150A Option 001) can be connected to the 3782A to provide a hard-copy print-out of measurement results.

### 1-96 Cartridge Tape Unit

1-97 The HP Model 9875A Cartridge Tape Unit can be connected, via the HP-IB, to the 3782A to collect result data.

Table 1-1 Specifications

Except where otherwise indicated, the following parameters are warranted performance specifications. Parameters described as "typical" or "nominal" are supplemental characteristics which provide a useful indication of typical, but non-warranted, performance characteristics.

## 3781A Pattern Generator

### DATA OUTPUTS

#### Data Output

**Bit Rates:** slide switch selects 704, 2048, 8448, 34368 kb/s.

**Format:** code — RZ AMI or RZ HDB3 (50%  $\pm$  6% pulse width on internal clock); NRZ pulse width selected by internal links.

binary — RZ or NRZ selected by internal links.

**Impedance:** 75 $\Omega$  unbalanced to GND on all four bit rates;  
120 $\Omega$  balanced on 704 and 2048 kb/s only.

**Connectors:** BNC (75 $\Omega$ ); 3-pin Siemens (120 $\Omega$ ).

**Amplitude:**

Bit Rate (kb/s)	Peak Voltage	
	75 $\Omega$ O/P	120 $\Omega$ O/P
704	2.37	3
2048	2.37	3
8448	2.37	—
34368	1	—

Note: In binary format, the output voltage will be peak-to-peak voltage of the above figures with low level as 0V.

**Tolerance:**  $\pm$  10%.

**+ve/—ve Pulse Amplitude Ratio:** 1.0  $\pm$  0.05.

**Transition Times:** < 5 ns (75 $\Omega$ )  
< 10 ns (120 $\Omega$ ).

**Overshoot:** < 10% of pulse amplitude.

**Protection:** open/short circuit protected; max short term voltage  $\pm$  6V.

#### Delay Data Output

**Delay:** 12 bits relative to DATA OUTPUT.

Other specifications same as 75 $\Omega$  unbalanced DATA OUTPUT.

#### Data Monitor Output

**Data:** same as DATA OUTPUT.

**Format:** binary NRZ.

**Impedance:** nominal 75 $\Omega$  unbalanced.

**Connector:** BNC.

**Amplitude:** nominal TTL levels.

**External Load:**  $\geq$  75 $\Omega$  to GND dc or  $\geq$  75 $\Omega$  ac.

### CLOCK

#### Internal Clock

**Frequency:** four crystal-controlled clocks at 704, 2048, 8448 and 34368 kHz.

**Accuracy:** setting tolerance better than  $\pm$  3 ppm at ambient temperature.

**Stability:** typically better than  $\pm$  12 ppm, 0°C to 55°C; typically better than  $\pm$  5 ppm/year aging.

#### External Clock

**Frequency:** 1 kHz to 50 MHz.

**Impedance:** nominal 75 $\Omega$  unbalanced.

**Connector:** BNC.

**Termination:** GND or  $-2V$ , nominal levels.

**Triggering:** 8 ns min pulse width, choice of AUTO, GND or ECL nominal thresholds.

**Sensitivity:** better than 500 mV pk-pk.

**Amplitude:** 5V pk-pk max within limits of  $\pm$  5V.

**Indicator:** LED illuminated if clock transitions present.

#### Clock Monitor Output

**Source:** internal or external clock.

**Format:** continuous.

**Impedance:** nominal 75 $\Omega$  unbalanced.

**Connector:** BNC.

**Amplitude:** nominal TTL levels.

**External Load:**  $\geq$  75 $\Omega$  to GND dc or  $\geq$  75 $\Omega$  ac.

### PATTERNS

#### PRBS

**Polynomials:**  $2^9 - 1$  to CCITT Rec. V.52 ( $D^9 + D^5 + 1 = 0$ );

$2^{15} - 1$  to CCITT Rec. 0.151 ( $D^{15} + D^{14} + 1 = 0$ );

$2^{23} - 1$  to CCITT Rec. 0.151 ( $D^{23} + D^{18} + 1 = 0$ ).

#### WORD

**16-BIT WORD:** comprised of four 4-bit serial combination A, B, C & D; contents of A, B, C or D can be set by pushbuttons.

**ALT WORD:** 8-bit WORD AB can be alternated with 8-bit WORD CD under control of externally applied signal via the Alt Word Input.

**Fixed Pattern:** 1111/AIS (Alarm Indication Signal).

#### Zero Substitution

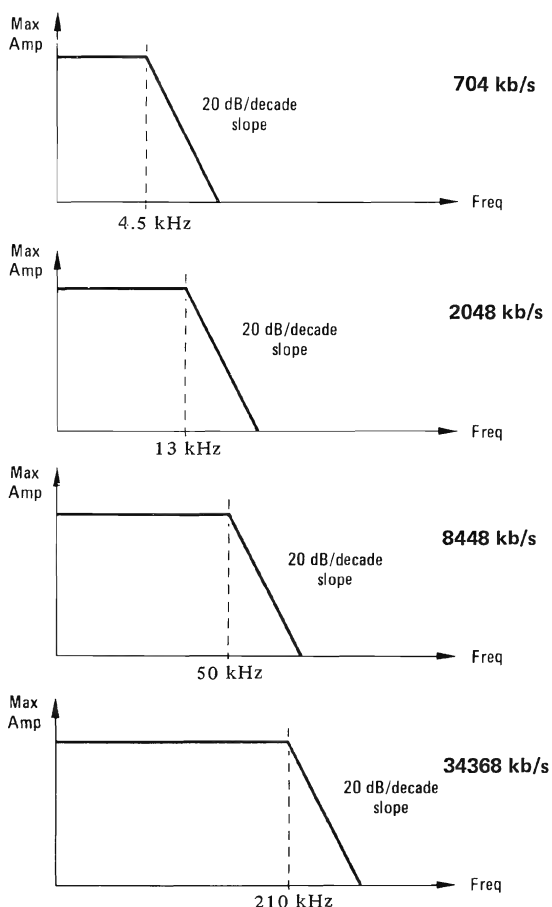
Sequence can be gated off for a number of clock periods variable over the range 0 to 120 in steps of 8. Gating occurs every sequence 2 bits after the leading edge of the PRBS trigger pulse, when viewed at the Data Monitor Output.

#### Error Add

Binary or code errors are added as an error rate of  $10^{-5}$  or  $10^{-3}$ , or a single error via a pushbutton switch.

## JITTER MODULATION

Timing jitter can be added to the clock and data output signals by applying an external modulating source. The typical jitter amplitude/frequency response available is shown below for constant modulation input amplitude.



### Jitter Modulation Input

**Frequency Range:** dc to 5% of bit rate (704, 2048 and 8448kb/s).  
dc to 2.5% of bit rate (34368kb/s).

**Impedance:** nominal 50Ω unbalanced to GND.

**Connector:** BNC.

**Sensitivity:** nominal 2 bits/V (pk-pk figures at 5 Hz).

**Display:** AB,CD LED display of pk-pk jitter (bits); flashes when out of range; valid for periodic modulating frequencies down to 5 Hz; accurate to  $\pm 5\% \pm 0.1$  bits.

**Jitter Output Amplitude:** 10.10 bits pk-pk max.

## OTHER OUTPUTS & INPUTS

### Pattern Trigger Output

**Format:** one pulse every PRBS or WORD.

**Position** (of rising edge of trigger pulse with respect to Data Monitor Output):

PRBS — leading edge of trigger pulse is 4-bits after start of longest run of ones for  $2^{15}-1$  and  $2^{23}-1$ , or zeros for  $2^9-1$ ;

WORD — leading edge of trigger pulse is 3-bits before bit 1 of word segment A.

**Impedance:** nominal 50Ω unbalanced to GND.

**Connector:** BNC.

**Amplitude:** fixed, min 1V pk.

**Width:** one clock period (except with zero substitution when width stretched to approx that of zero block).

**Protection:** open/short circuit protected,  $\pm 5V$  max short term voltage.

### Alt WORD Input

External signal applied to alternate patterns AB and CD.

**External Input Sensitivity:** 250 mV pk-pk square wave, dc to 100 kHz; 0.5V pk-pk sinewave, 200 Hz to 100 kHz.

**Maximum Input Voltage:** 5V rms.

**Impedance:** nominal 1 kΩ.

**Connector:** BNC.

## HP-IB FACILITIES

### General

**Mode:** "ADDRESSABLE" only.

**LOCAL Switch:** allows switching from "remote" to "local" control, except when the controller has issued a "local lockout" command.

**Flags:** Local, Remote, Listen, Talk, SRQ.

**Implementation:** SH1 (complete capability);  
AH1 (complete capability);  
T6 (basic talker, serial poll, unaddress if MLA);  
TE0 (no capability);  
L4 (basic listener, unaddress if MTA);  
LE0 (no capability);  
SR1 (complete capability);  
RL1 (complete capability);  
PP0 (no capability);  
DC1 (complete capability);  
DT0 (no capability);  
C0 (no capability).

### Controlling Masks

To permit flexibility in the use of the 3781A, some operating parameters are governed by "masks". At power-on, these masks are given default values which may be overwritten in the local and remote status. Full details are given in the 3781A/3782A Operating Manual or Quick Reference Guide.

### ADDRESSABLE Mode

**Scope:** used when 3781A operates with an external controller; allows control of all switches except Power, Line Voltage Selection, Local and HP-IB Address.

**Functions:** overwrite a slide-switch or pushbutton; request the current jitter amplitude display; request the current external clock status; request the current switch positions and masks; load the switch positions and masks, "local lockout" facility; power-on reset; service requests controllable by masks.



# 3782A Error Detector

## DATA INPUTS

### Ternary Data Inputs

**Bit Rates:** slide switch selects 704, 2048, 8448 and 34368 kb/s.  
**Format:** code — RZ AMI or RZ HDB3 (50%  $\pm$  6% pulse width of bit period).

**Impedance:** 75 $\Omega$  unbalanced to GND on all four bit rates;  
 120 $\Omega$  balanced on 704 and 2048 kb/s only.

**Connectors:** BNC (75 $\Omega$ ); 3-pin Siemens (120 $\Omega$ ).

**Amplitude:** automatic  $\sqrt{f}$  equalization.

Parameter	Bit Rate (kb/s)			
	704	2048	8448	34368
Nominal max peak voltage (75 $\Omega$ )	2.37	2.37	2.37	1
Nominal max peak voltage (120 $\Omega$ )	3	3	—	—
Max $\sqrt{f}$ loss at $\frac{1}{2}$ bit rate (dB)	3	6	6	12

**Indicator:** LED illuminated if data transitions present.

### Monitor Mode

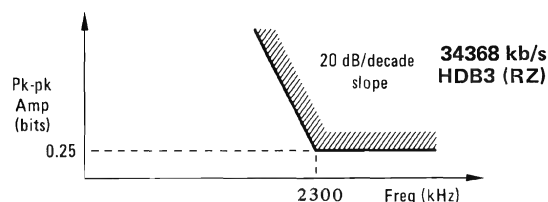
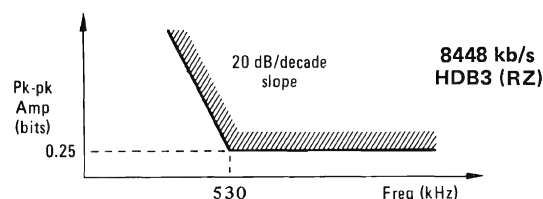
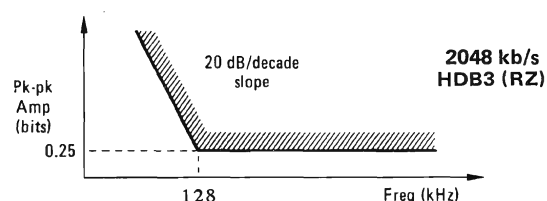
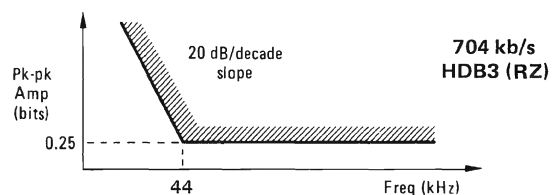
By toggling the MON/TERM position on the slide switch, the monitor or terminated mode can be selected. In the monitor mode, additional gain is provided to allow for flat loss at equipment monitor points.

**Additional Gain:** 30dB for 704, 2048 and 8448 kb/s  
 26dB for 34368 kb/s

**Indicator:** LED illuminated if MONitor mode selected

### Ternary Data Input Jitter Tolerance

The balanced/unbalanced data inputs operate without error in the presence of a signal with a jitter content within the nominal mask shown.



### Binary Data Input (rear panel, switch selected)

**Bit Rate:** 1 kb/s to 50 Mb/s.

**Format:** binary NRZ.

**Polarity:** DATA or  $\overline{\text{DATA}}$ , switch selectable.

**Impedance:** nominal 75 $\Omega$  unbalanced.

**Connector:** BNC.

**Termination:** GND.

**Amplitude:** nominal TTL levels.

## DATA OUTPUT

### Data Monitor Output

**Source:** decoded ternary, or binary, input data.

**Format:** binary NRZ.

**Impedance:** nominal low unbalanced to GND.

**Connector:** BNC.

**Amplitude:** nominal ECL levels.

**External Load:** 50 $\Omega$  into  $-2V$ , dc coupled; 50 $\Omega$  into GND, ac coupled.

**Protection:** 100 mA fuse.

## CLOCK

### Recovered Clock (ternary data inputs)

**Frequency:** recovered from RZ HDB3 at 704, 2048, 8448 and 34368 kHz; recovered from RZ AMI at 704 and 2048 kHz with zero substitution  $\leq$  24 zeros.

### Binary Clock Input (rear panel, switch selected)

**Frequency:** 1 kHz to 50 MHz.

**Impedance:** nominal 75 $\Omega$  unbalanced.

**Connector:** BNC.

**Termination:** GND.

**Amplitude:** nominal TTL levels.

## Clock Monitor Output

**Source:** recovered clock from Ternary Data Inputs or rear-panel Binary Clock Input.

**Format:** continuous.

**Impedance:** nominal low unbalanced to GND.

**Connector:** BNC.

**Amplitude:** nominal ECL levels.

**Duty Cycle:** nominal 50% on recovered clock.

**External Load:** 50 $\Omega$  into -2V, dc coupled; 50 $\Omega$  into GND, ac coupled.

**Protection:** 100 mA fuse.

## PATTERNS

### PRBS

**Polynomials:**  $2^9 - 1$  to CCITT Rec. V.52 ( $D^9 + D^5 + 1 = 0$ );  
 $2^{15} - 1$  to CCITT Rec. 0.151 ( $D^{15} + D^{14} + 1 = 0$ );  
 $2^{23} - 1$  to CCITT Rec. 0.151 ( $D^{23} + D^{18} + 1 = 0$ ).

### WORD

**16-BIT WORD:** comprised of four 4-bit serial combination A, B, C & D; contents of A, B, C or D can be set by pushbuttons.

**Fixed Pattern:** 1111.

### Zero Substitution (PRBS only)

Sequence can be gated off for a number of clock periods variable over the range 0 to 120 in steps of 8. Gating occurs every sequence following the PRBS trigger.

## SYNCHRONIZATION

### Pattern Sync

**Modes:** automatic or manual.

**Sync Loss:** approx 1000 errors in 30000 clock periods.

**Sync Gain:** < 10 errors in 300 clock periods.

## TRIGGER OUTPUTS

### Pattern Trigger Output

**Format:** one pulse every PRBS or WORD.

**Position** (of the rising edge of trigger pulse with respect to Data Monitor Output):

PRBS -- 5 bits after start of longest run of ones for  $2^{15} - 1$  and  $2^{23} - 1$ , or zeros for  $2^9 - 1$ ;

WORD -- 2 bits before start of bit 1 of word segment A.

**Impedance:** nominal 50 $\Omega$  unbalanced to GND.

**Connector:** BNC.

**Amplitude:** fixed; min 1V pk.

**Width:** one clock period (except with zero substitution when width stretched to approx that of zero block).

**Protection:** open/short circuit protected;  $\pm 5V$  max short term voltage.

## MEASUREMENTS

### Binary Errors

Closed loop bit-by-bit detection at binary level.

### Code Errors

Code violation detection as follows:

**AMI:** bipolar violations are code errors.

**HDB3:** "violation of violations" rule, i.e., two consecutive bipolar violations with the same polarity.

## DISPLAY MODES

### Error Rate

**Method:** totalises errors over selected gating period and automatically scales the answer.

**Internal Gating:**  $10^6$ ,  $10^8$ ,  $10^{10}$  clock periods or 1 sec, 10 sec, 1 min, 10 mins, 1 hr, repetitive.

**Manual Gating:** START and STOP pushbutton switches.

**External Gating:** ECL compatible rear panel BNC input, high level enables count, nominal 50 $\Omega$  unbalanced impedance with nominal -2V termination and 100 mA fuse protection.

**Display:** A.B  $10^{-mn}$  LED.

**Range:** mn = 1 to 19 with automatic scaling.

**Accuracy:** indication given if measurement result is based on < 100 errors.

**Note:** Gating periods of 1 sec, 10 sec, 1 min, 10 mins, 1 hr, manual and external can be used only for Ternary Data Inputs. Other Switch Settings are flagged by an Error Code.

### Error Count

**Method:** totalizes errors over selected gating period.

**Gating:** same as Error Rate.

**Display:** 5 digit LED with leading zero blanking.

**Range:** when count exceeds 99999, display automatically changes to A.B  $10^{mn}$  with automatic round-up to a max count of  $9.9 \cdot 10^{19}$ .

### Error Seconds

**Method:** totalises the number of seconds which contain one or more errors.

**Gating:** same as Error Rate.

**Display:** same as Error Count.

**Range:** same as Error Count.

### Error Free Seconds

**Method:** totalizes the number of seconds during which no errors occur.

**Gating:** same as Error Rate.

**Display:** same as Error Count.

**Range:** same as Error Count.

## Error Codes

The error code will flash repeatedly if any of the conditions is violated.

Code	Meaning
1	Error Rate display not permitted for Binary Inputs when Gating Period set to 1 sec, 10 sec, 1 min, 10 mins, 1 hr, external or manual.
4	Code Error measurements not permitted for Binary Input.
5	Code '31' not permitted for HP-IB Address.
6	Talk Only mode not permitted when controller connected.
7	Power Interrupt and measurement restarted.

## Real-Time Clock

When rear panel switch set to VIEW/SET, local time can be viewed or set on the display in hours and minutes. With rear panel switch in NORMAL position, display returns to normal display mode.

**Display:** HH MM.

**Setting:** START pushbutton sets Hours; STOP pushbutton sets Minutes; hold activated by depressing both pushbuttons; Seconds set to zero when either START or STOP pushbuttons pressed.

**Accuracy:** setting tolerance better than  $\pm 3$  ppm at ambient temperature.

**Stability:** typically better than  $\pm 12$  ppm,  $0^{\circ}\text{C}$  to  $55^{\circ}\text{C}$ , typically better than  $\pm 5$  ppm/year aging.

**Note:** When real-time clock is set, a DAY count is initialised to 1. As 24 hours roll over, an output message DAY n (where n is the day count) is issued. Total range of the clock is 99 days, 23 hours, 59 minutes and 59 seconds.

## LED Flags

**Gating:** indicates measurement in progress.

**Errors:** indicates errors being detected; each error pulse stretched to approx 500ms.

**Pattern Sync Loss:** indicates local pattern reference has lost sync, remains lit for at least 500 ms.

**AIS:** illuminated when an all ones signal is detected with a nominal error rate of  $< 10^{-3}$ .

**< 100 Errors:** indicates an Error Rate result based on  $< 100$  errors.

## OTHER OUTPUTS

### Error Output

**Format:** one pulse per error.

**Impedance:** nominal  $50\Omega$  unbalanced to GND.

**Connector:** BNC.

**Amplitude:** min. 1V pk-pk about GND.

**Protection:** open/short circuit protected;  $\pm 5\text{V}$  max short-term voltage.

## HP-IB FACILITIES

### General

**Modes:** "ADDRESSABLE" or "TALK ONLY", switch-selected (rear panel).

**LOCAL Switch:** allows switching from "remote" to "local" control except when the controller has issued a "local lockout" command.

**Flags:** Local, Remote, Listen, Talk, SRQ.

**Implementation:** SH1 (complete capability);  
AH1 (complete capability);  
T5 (basic talker, serial poll, talk only mode, unaddress if MLA);  
TE0 (no capability);  
L4 (basic listener, unaddress if MTA);  
LE0 (no capability);  
SR1 (complete capability);  
RL1 (complete capability);  
PP0 (no capability);  
DC1 (complete capability);  
DT0 (no capability);  
C0 (no capability).

### Controlling Masks

To permit flexibility in the use of the 3782A, many of the important operating parameters are governed by "masks". At power-on, these masks are given default values which may be overwritten in the local and remote states of the "ADDRESSABLE" mode. In the "TALK ONLY" mode, five of the masks are controlled by the five parts of the HP-IB Address switch. Full details are given in the 3781A/3782A Operating Manual or Quick Reference Guide.

### ADDRESSABLE Mode

**Scope:** used when 3782A operates with an external controller; allows control of all switches except Power, Line Voltage Selection, Local, HP-IB Address, ADDRESSABLE/TALK ONLY and Real Time Clock.

**Functions:** overwrite a slide-switch or pushbutton; request the current display answer; request the flag information (except Errors); initialise the internal real-time clock; request the current switch positions and masks; load the switch positions and masks, "local lockout" facility; power-on reset; service requests controllable by masks.

### TALK ONLY Mode

**Scope:** used when 3782A operates without an external controller.  
**Function:** provides output messages to a peripheral such as 5150A Thermal Printer or 9875A Cartridge Tape Unit connected in "LISTEN ONLY" mode. Output result format defined by the other five segments (LSB to MSB of the address switch) as follows:

Segment	Message Format	Switch Setting
LSB	1 Issues all four answers of display mode switch at end of gating period.	0
	Issues answer as indicated on display mode switch at end of gating period.	1
	2 Message output without time.	0
	Message output with time.	1
	3 Not used.	—
	4 EOI issued concurrent with terminator.	0
	EOI not issued concurrent with terminator.	1
MSB	5 Error secs messages not issued automatically.	0
	Error Secs messages issued automatically.	1

### Result Print Threshold Switch

**Function:** governs whether results are issued (TALK ONLY and ADDRESSABLE modes), a service request is generated and another gating period started automatically (ADDRESSABLE mode only).

**Switch Positions:** N = 15 threshold always satisfied; N = 14 threshold satisfied only if one or more errors have occurred;  $0 \leq N \leq 13$  threshold satisfied only if error rate is worse than  $1.0 \times 10^{-N}$  where N is the decimal value set as binary equivalent by the four-segment switch.

## General (3781A and 3782A)

### Power Supply

**Input voltages:** 115V —22%, +10%; 230V —18%, +10%.

**Frequency:** ac 48 to 66 Hz.

**Consumption:** approx 150 VA, each.

### Dimensions

**Width:** 335 mm (13.2 in).

**Height:** 195 mm (7.7 in).

**Depth:** 475 mm (18.7 in).

### Weight

**Net:** 11 kg (24.2 lb).

**Shipping:** 13.5 kg (29.7 lb).

### Environment

**Operating Temperature Range:** 0°C to 55°C.

**Storage Temperature Range:** —40°C to 75°C.

## Options 3781A

**Option 001** — provides four additional 1V pk outputs coded in HDB3/AMI, via 75Ω BNC connectors, on the rear panel.

**Option 002** — as standard but with small Siemens 75Ω connectors (1.6mm/5.6mm) in place of BNC connectors on the following ports: Clock Input, Clock Monitor Output, Data Monitor Output, Data Output, Delayed Data Output.

**Option 061** — rack-mounted version.

**Option 062** — rack mount to allow Option 001 outputs to be accessed from front panel.

## 3782A

**Option 002** — as standard but with small Siemens 75Ω connectors (1.6mm/5.6mm) in place of BNC connectors on the following ports: Data Input on front panel, all rear panel connectors except the Ext Gating Input.

**Option 061** — rack-mounted version.

**Option 062** — rack mount to allow front panel access to Binary/Ternary Input and Real-time clock switches, Binary Data and Clock Inputs and External Gating Input Connectors.

### OTHER OPTIONS (3781A and 3782A)

**Option 031** — German language in-lid instructions.

**Option 032** — French language in-lid instructions.

**Option 033** — Italian language in-lid instructions.

**Option 034** — Spanish language in-lid instructions.

**Note:** Unless one of these in-lid instructions options is ordered, the instruments will be supplied with English in-lid instructions.

**Option 910** — extra set of manuals.

## SECTION II

### INSTALLATION

#### 2-1 INTRODUCTION

2-2 This section contains information and instructions required to prepare the 3781A and 3782A for use. Included in this section are the initial inspection procedures, power and grounding requirements, fuse selection procedure, installation information and instructions on repacking for shipment.

#### 2-3 INITIAL INSPECTION

##### WARNING

**To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).**

2-4 Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked both mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1 and listed in Paragraph 1-89. Procedures for checking electrical operation are given in Section IV of the Service Manuals.

If the contents of the shipment are incomplete, if there is mechanical damage or defect, notify the nearest Hewlett-

Packard Office. If the instrument does not pass the electrical performance checks given in Section IV of the Service Manual, notify the nearest Hewlett-Packard Office. If the shipping container is also damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office. Keep the shipping materials for carrier's inspection. The Hewlett-Packard Office will arrange for repair or replacement without waiting for claim settlement.

#### 2-5 PREPARATION FOR USE

##### 2-6 Power Requirements



2-7 The 3781A and 3782A each requires a power source of 115V (+10%, -22%) or 230V (+10%, -18%) at a frequency between 48 to 66Hz. Total power consumption of each is less than 150VA.

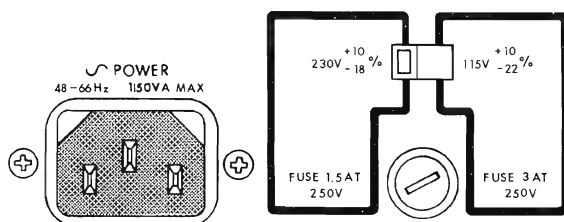
##### CAUTION

**Before connecting these instruments to a power outlet ensure that the voltage selector is correctly set for the voltage of the power source and a fuse of the correct rating is fitted.**

##### 2-8 Line Voltage Selection



2-9 Figure 2-1 provides instructions on the setting of the voltage selector. Fuse ratings for the different power source voltages are given in Table 2-1.



1. Remove power cord.
2. Insert screwdriver into slot of voltage selector and push to left or right (depending on supply voltage).
3. Unscrew fuse compartment end cap, fit appropriate fuse and replace end cap.

Figure 2-1 Line Voltage Selection

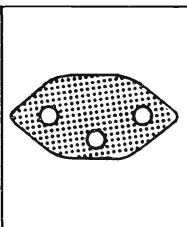
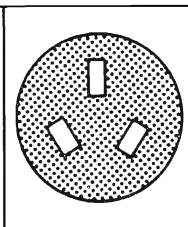
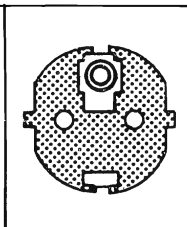
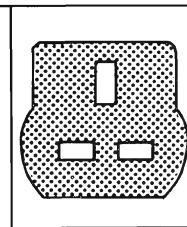
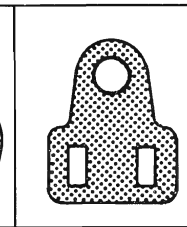
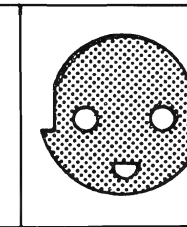
Table 2-1 Fuses

Nominal Line Voltage	Fuse Rating	HP Part Number
115V +10% -22%	*3A 250V (TIME DELAY)	2110-0381
230V +10% -18%	*1.5A 250V (TIME DELAY)	2110-0304

\* Appropriate fuse supplied with instrument.

2-10 Power Cord

2-11 The power cord supplied with each instrument varies with the country of destination. Figure 2-2 illustrates the standard power plug and cord configurations that are commonly used. The part number shown beneath each plug is the part number of the appropriate power cord and plug. If the appropriate power cord is not included with the instrument notify the nearest HP Sales/Service Office and a replacement will be provided.

					
8120-2104	8120-1369	*8120-1689	8120-1351	8120-1378	8120-2956

Note\*: In order to pass German Std. FTZ527 Power cord 8120-2857 must be fitted to the instrument.  
Colour codes for each cable are: LINE-Brown, NEUTRAL-Blue, EARTH-Green/Yellow.

Figure 2-2 Power Cable and Mains Plug Part Numbers

WARNING

TO AVOID THE POSSIBILITY OF INJURY OR DEATH, THE FOLLOWING PRECAUTIONS MUST BE FOLLOWED BEFORE THE INSTRUMENT IS SWITCHED ON:

(a) Note that the protection provided by grounding the instrument cabinet may be lost if any power cable other than the three-pronged type supplied is used to couple the ac line voltage to the instrument.

(b) If this instrument is to be energized via an auto-transformer to reduce or increase the line voltage, make sure that the common terminal is connected to the neutral pole of the power source.

(c) The power cable plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor (grounding).

## 2-12 HP-IB Address Selection



2-13 The 3781A and 3782A HP-IB talk and listen address switches are located on the rear panel.

2-14 Use a pencil to set the switches to the desired HP-IB address. The switches are illustrated in Figure 2-3. The allowable HP-IB address codes are given in Table 2-2.

## 2-15 Interconnections

2-16 Interconnection data for the Hewlett-Packard Interface Bus (HP-IB) is provided in Figure 2-4.

## 2-17 Mating Connectors

2-18 **Interface Connector.** The HP-IB mating connector is shown in Figure 2-4. (Note that the two securing screws are metric.)

2-19 **Coaxial Connectors.** Coaxial mating connectors used with these instruments should be  $75\Omega$  coaxial BNC male connectors or  $120\Omega$  3-pin Siemens connectors.

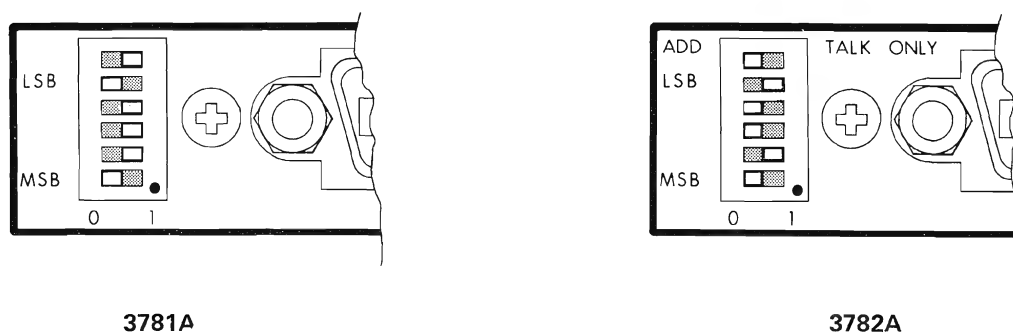


Figure 2-3 HP-IB Address Switches

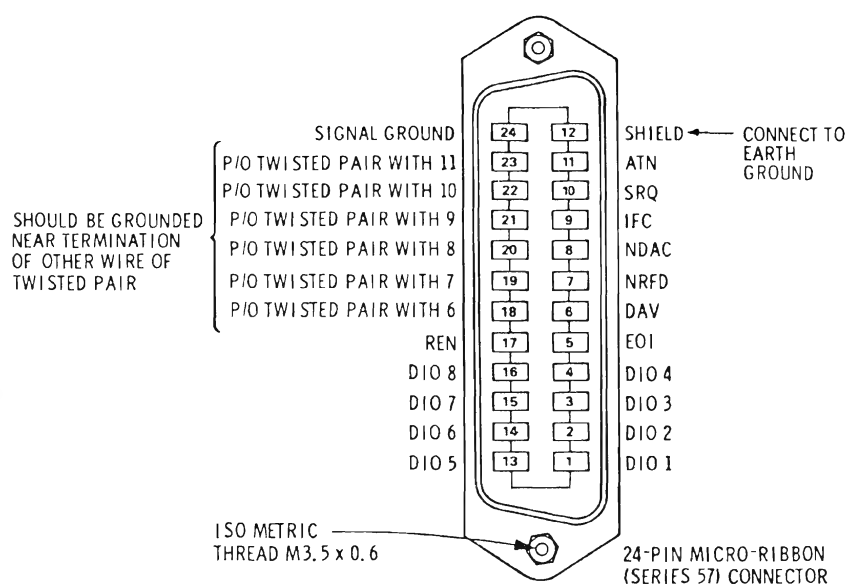


Figure 2-4 Hewlett-Packard Interface Bus Connection

### Logic Levels

The Hewlett-Packard Interface Bus logic levels are TTL compatible, i.e., the true (1) state is 0.0V dc to +0.4V dc and the false (0) state is +2.5V dc to +5.0V dc.

### Programming and Output Data Format

Refer to Section III (Operation).

### Mating Connector

HP1251-0293; Amphenol 57-30240.

### Mating Cables Available

HP10833A, 1 metre (3.3ft)  
 HP10833B, 2 metres (6.6ft)  
 HP10833C, 4 metres (13.2ft)  
 HP10833D, 0.5 metres (1.6ft)

### Cabling Restrictions

1. An HP-IB System may contain no more than 2 metres (6ft) of connecting cable per instrument.
2. The maximum accumulative length of connecting cable for any HP-IB System is 20.0 metres (65.6ft).

Table 2-2 Allowable HP-IB Address Codes 

Address Switches					Talk Address Char- acter	Listen Address Char- acter	Decimal Equiva- lent
A5	A4	A3	A2	A1			
0	0	0	0	0	@	SP	0
0	0	0	0	1	A	!	1
0	0	0	1	0	B	"	2
0	0	0	1	1	C	#	3
0	0	1	0	0	D	\$	4
0	0	1	0	1	E	%	5
0	0	1	1	0	F	&	6
0	0	1	1	1	G	'	7
0	1	0	0	0	H	(	8
0	1	0	0	1	I	)	9
0	1	0	1	0	J	*	10
0	1	0	1	1	K	+	11
0	1	1	0	0	L	,	12
0	1	1	0	1	M	-	13
0	1	1	1	0	N	.	14
0	1	1	1	1	O	/	15
1	0	0	0	0	P	0	16
1	0	0	0	1	Q	1	17
1	0	0	1	0	R	2	18
1	0	0	1	1	S	3	19
1	0	1	0	0	T	4	20
1	0	1	0	1	U	5	21
1	0	1	1	0	V	6	22
1	0	1	1	1	W	7	23
1	1	0	0	0	X	8	24
1	1	0	0	1	Y	9	25
1	1	0	1	0	Z	:	26
1	1	0	1	1	[	;	27
1	1	1	0	0	\	<	28
1	1	1	0	1	]	=	29
1	1	1	1	0	^	>	30



## 2-20 Operating Environment

2-21 The instrument should be operated in temperatures within the range  $0^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$  and at altitudes up to 4,500 metres (15,000ft). At all times the instrument should be protected from temperature extremes and environments which cause condensation within the instrument.

## 2-22 RACK MOUNTING

2-23 A retro-fitable Rack Mount Kit is available for use with the 3781A and 3782A and can be purchased from your nearest Hewlett-Packard Office.

2-24 Instructions on conversion to rack mounting are included with the rack mount kit and are also reproduced on Page 2-6 for convenience.

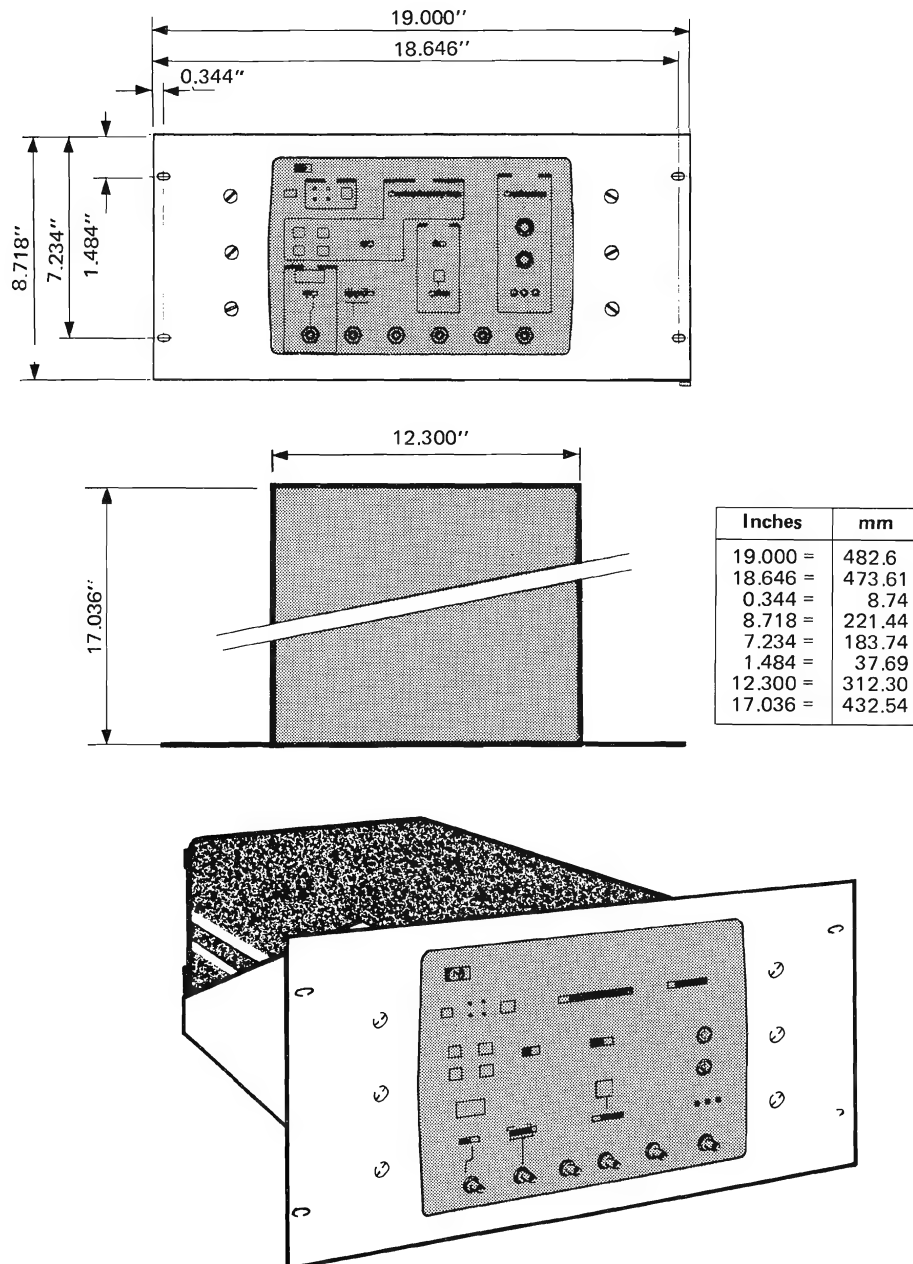


Figure 2-5 Rack Mounting (3781A)

## RETRO-FIT INSTRUCTIONS FOR RACK MOUNTING

If it is required to rack mount these instruments, order Rack Mount Kit HP Part Number 03771-60105. Parts relevant to rack-mounting these instruments, which are contained in this kit, are listed in Table 1.

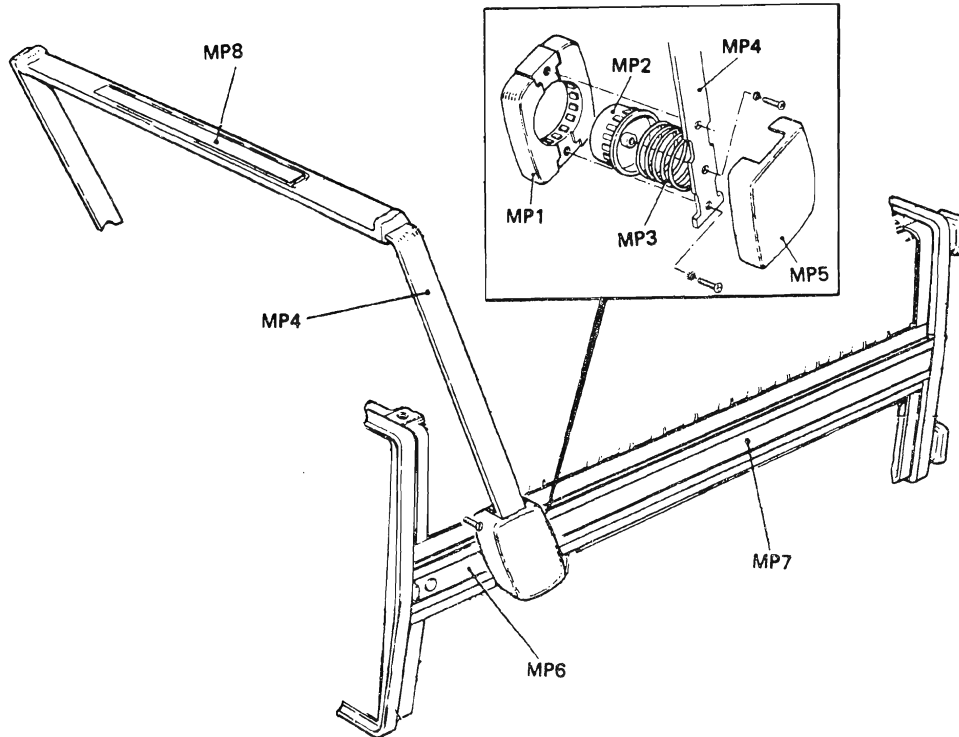
**Table 1 Rack Mount Kit Contents**

Description	HP Part Number	Quantity
Rack Front Panel	03771-20056	1
Rack Tray	03770-11160	1
Screw	2940-0115	6
Nut	2950-0004	6
Washer-Lock	2190-0060	6
Screw	2360-0133	2
Washer-Flat	3050-0010	2
Washer-Lock	2190-0006	2
Washer-Flat	3050-8735	6

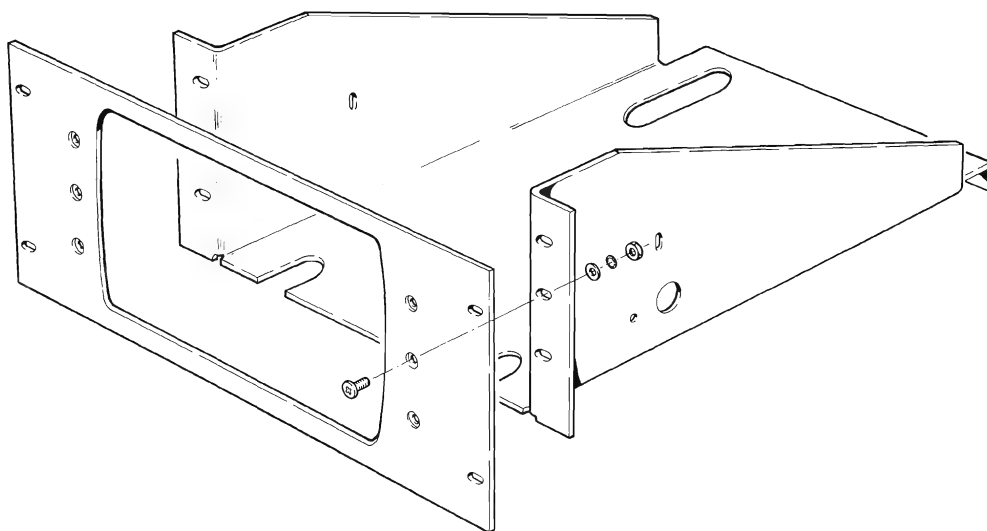
*Discard all other parts contained in kit*

## Retro-fitting Procedure

1. Ensure that the instrument is switched-off and the power cord is disconnected.
2. Referring to Figure 1, remove the push-fit hub cover (MP5) from both sides of the instrument. (Finger pressure only is required to unclip MP5.) Discard the hub covers.
3. Remove the three locating screws on each side of the handle.
4. Remove and discard the handle (MP4), springs (MP3) and gear rings (MP1).
5. Re-locate the gear hubs (MP2) — without screws — to their original locations. (These parts act as spacers between the instrument frame and the rack tray shown in Figure 2.)
6. Locate the instrument into rack tray. Ensure that instrument rubber feet locate into eccentric slots in rack tray and gear hubs (MP2) line-up with holes at side of rack tray.
7. Retain rack tray to instrument by fixing screws (Part No. 2360-0133) through side of rack tray into centre of gear hub (MP2). **Do not tighten screws.**
8. Mount rack front panel (MP10) onto rack tray, using six sets of screws, lock washers and nuts. (Note: the rack front panel is asymmetrical and will only fit in one position.)
9. Tighten all screws.



**Figure 1 Hardware Details**



**Figure 2 Rack Mount Hardware**

## 2-25 STORAGE AND SHIPMENT

### 2-26 Environment

2-27 The instrument may be stored or shipped in environments within the following limits:

Temperature . . . . .	−40°C to +65°C
Altitude . . . . .	Up to 15,200 metres (50,000 feet)

The instrument should also be protected from temperature extremes which cause condensation within the instrument.

### 2-28 Repackaging for Shipment

2-29 **Tagging for Service.** If the instrument is being returned to Hewlett-Packard for service, please complete one of the blue repair tags located at the beginning of the Service Manual and attach it to the instrument.

2-30 **Original Packaging.** Containers and materials identical to those used in factory packaging are available through Hewlett-Packard Offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the

type of service required, return address, Model number, and full serial number. Also, mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by Model number and full serial number.

2-31 **Other Packaging.** The following general instructions should be used for re-packing with commercially available materials.

- (a) Wrap instrument in heavy paper or plastic. (If shipping to Hewlett-Packard Office or Service Centre, attach a tag indicating type of service required, return address, model number and full serial number.)
- (b) Use strong shipping container. A double wall carton made of 350-pound test material is adequate.
- (c) Use a layer of shock-absorbing material 70 to 100 mm (3- to 4-inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container. Protect control panel with cardboard.
- (d) Seal shipping container securely.
- (e) Mark shipping container FRAGILE to ensure careful handling.
- (f) In any correspondence, refer to instrument by Model number and full serial number.

## SECTION III

### OPERATION

#### 3-1 INTRODUCTION

3-2 This section explains the functions of the controls, connectors and indicators of the HP Models 3781A Pattern Generator and 3782A Error Detector. Also included in this section is an explanation of the HP-IB functions of both instruments and a check procedure on the main functions of the instrument. At the rear of this section are instructions for maintenance of the air filters.

3-3 For convenience, the fold-out contains the key to all front-panel controls, etc.

#### 3-4 POWER CONTROLS AND CONNECTORS

3-5 Details of setting the supply voltage and fuse selection are given in Section II.

#### WARNING

**Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it**

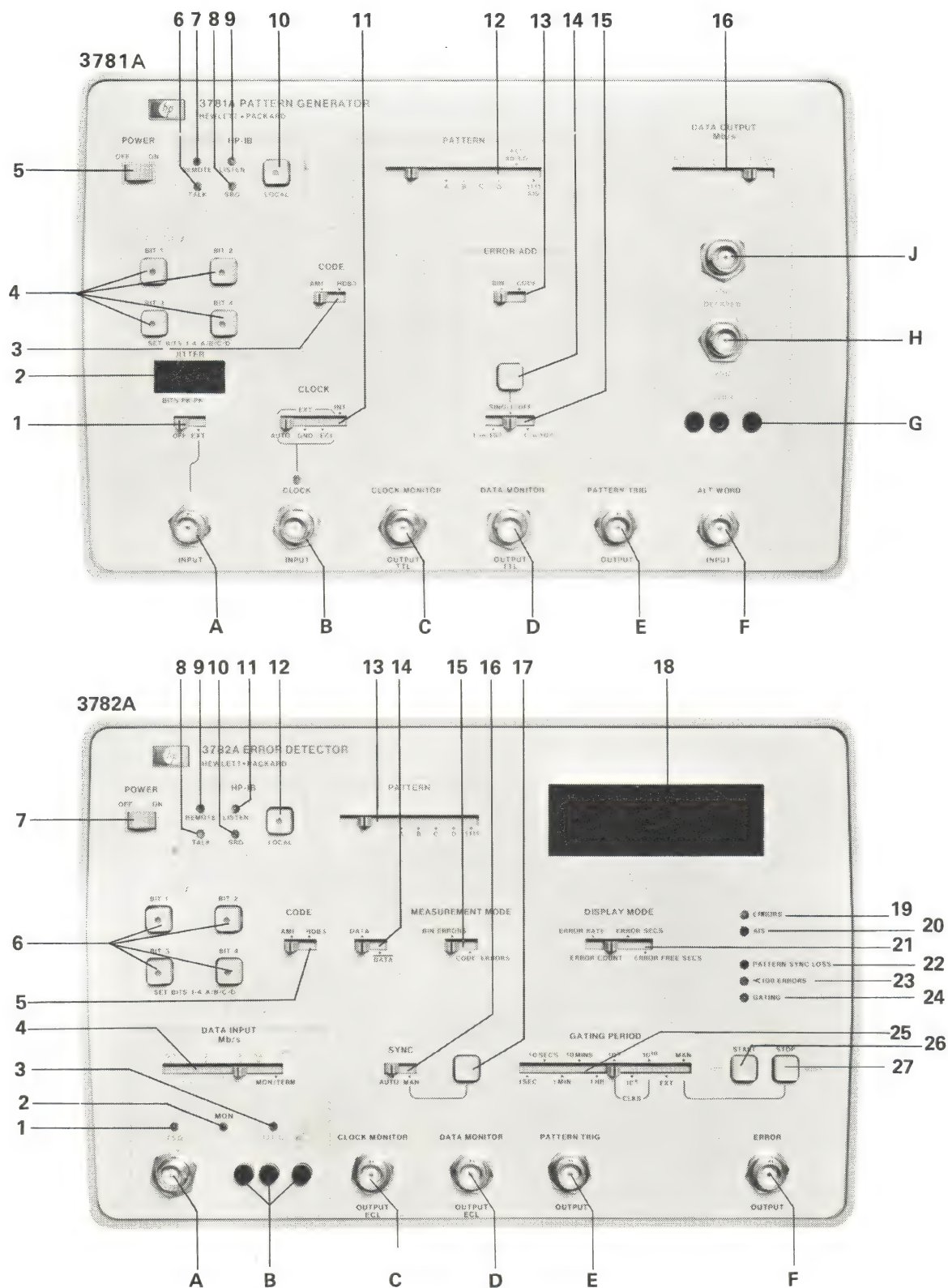
**should be connected to a protective earth ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.**

**Only fuses with the required rated current and of specified type should be used. Do not use repaired fuses or short-circuited fuse holders. To do so could cause a shock or fire hazard.**

#### CAUTION

**Before the instrument is switched-on, it must be set to the voltage of the power source or damage to the instrument may result.**

3-6 The POWER switch (5) in 3781A and (7) in 3782A controls the ac power input to the instrument.



### Figure 3-1 Key to Front Panel Controls, Connectors and Indicators

### 3-7 3781A Pattern Generator CONTROLS, CONNECTORS AND INDICATORS

#### 3-8 Front-Panel Description

- A JITTER INPUT operates at the four bit rates — 704, 2048, 8448 and 34368kb/s. The frequency range of the JITTER INPUT is dc to 5% of the bit rate. The maximum jitter amplitude obtainable is 10.1 bits pk-pk.
- B CLOCK INPUT accepts an external clock input signal in the range 1kHz to 50MHz. The maximum acceptable input amplitude is 5V pk-pk within excursion limits of  $\pm 5V$ . This  $75\Omega$  unbalanced input is triggered by automatic, GND or ECL threshold levels with a minimum pulse width of 8ns.
- C CLOCK MONITOR OUTPUT TTL allows the clock signal to be monitored or used with binary data. It is a low-impedance output giving nominal TTL levels. The external loading should be  $50\Omega$  to  $-2V$  dc or  $50\Omega$  to GND ac.
- D DATA MONITOR OUTPUT TTL supplies the same information as the DATA OUTPUTS — but in a binary format. It is a low-impedance output giving nominal TTL levels.
- E PATTERN TRIG OUTPUT supplies one pulse every PRBS or WORD. The position of the rising edge of the trigger pulse is with respect to the DATA MONITOR OUTPUT. For PRBS, the leading edge of trigger pulse is 4 bits after start of longest run of ones (for  $2^{15}-1$  and  $2^{23}-1$ ) or zeros (for  $2^9-1$ ). For WORD, the leading edge of the trigger pulse is 3 bits before bit 1 of word segment A.
- F ALT WORD INPUT allows an external signal to be applied to alternate the two programmable 8-bit patterns AB/CD.
- G  $120\Omega$  DATA OUTPUT is a balanced data output providing a 3V pk signal at 704 and 2048kb/s when the DATA OUTPUT switch (16) is set to the lower 0.7 and 2 modes respectively.
- H  $75\Omega$  DELAYED DATA OUTPUT provides the necessary signals and levels, depending on the position of the DATA OUTPUT switch (16). The DELAYED DATA OUTPUT signal has the same characteristics as the DATA OUTPUT, except that the signal is delayed by 12 bits.
- J  $75\Omega$  DATA OUTPUT provides the necessary signals and levels, depending on the position of the DATA OUTPUT switch (16).
- 1 JITTER switch activates the jitter modulation circuitry and the amount of jitter added to the output data is displayed in the JITTER LED display (2).
- 2 JITTER LED display gives a 4-digit display of pk-pk jitter (bits). The display flashes when the signal is out-of-range. The display is valid for periodic modulating frequencies down to 5Hz.
- 3 CODE switch selects either AMI or HDB3.
- 4 ZERO SUB/16-BIT WORD push-buttons have dual functions. When used in conjunction with the PRBS modes of the PATTERN switch (12), the push-buttons are used in the ZERO SUB mode. The numbers of zeros substituted in the PRBS may vary from 0 to 120 in steps of 8 — i.e. cumulative selection of the push-buttons. When used in conjunction with the 16-BIT WORD modes of the PATTERN switch (12), the push-buttons are used in the 16-BIT WORD mode. The 16-bit word is a serial combination of 4-bit words A, B, C and D — the contents of which are set by the push-buttons.
- 5 POWER switch activates the entire instrument by controlling the ac supply.
- 6 TALK LED (HP-IB function) indicates that the 3781A is able to pass information over the HP-IB.
- 7 REMOTE LED (HP-IB function) indicates that the 3781A is being controlled from an external controller.
- 8 SRQ LED (HP-IB function) indicates that the 3781A is requesting service from the HP-IB.
- 9 LISTEN LED (HP-IB function) indicates that the 3781A is listening to information from the HP-IB.
- 10 LOCAL switch (HP-IB function) allows the 3781A to be switched from Remote to Local control (indicated by the REMOTE and LOCAL LEDs), except when a Local Lockout signal has been issued by the Controller. The LOCAL LED indicates that the 3781A is being controlled via the front panel.
- 11 CLOCK switch selects which clock source will be used in the 3781A. If the INT mode is selected, a clock rate dependent on the position of the DATA OUTPUT switch (16) is internally generated. In the EXT mode, one of three positions is available (AUTO, GND and ECL) giving a choice of input termination and trigger level. This allows the 3781A to be operated over the frequency range 1kHz to 50MHz.

- 12 PATTERN switch can be segmented into two groups — PRBS and WORD.

PRBS: the 3781A offers a choice of three PRBS modes —  $2^9 - 1$  (511 bits),  $2^{15} - 1$  (32767 bits) and  $2^{23} - 1$  (8388607 bits). The PRBS patterns can have zero substitution superimposed when the ZERO SUB push-buttons (4) are set.

WORD: 16-BIT WORD — the 3781A offers a selection of 16-bit words. The 16-bit word is the serial combination of four 4-bit words A, B, C and D. Contents of A, B, C or D are set by the 16-BIT WORD push-buttons (4).

ALT AB/CD — When an external signal is applied to ALT WORD INPUT (F), the 8-bit word contained in AB is alternated with the 8-bit word contained in CD.

1111/AIS — a fixed pattern of all ones which can be used as Alarm Indication Signal (AIS).

- 13 Part of the ERROR ADD facility which selects between binary or code errors.
- 14 and 15 Part of the ERROR ADD facility selecting the degree of induced error in the signal. A single error, or one error in every  $10^3$  (1000) or  $10^5$  (100,000) clock periods may be introduced.
- 16 DATA OUTPUT switch selects the bit rate with the appropriate interface voltage levels, depending on the digital hierarchical level to which the 3781A is connected. The bit rates available are 704, 2048, 8448 and 34368kb/s.

### 3-9 Rear-Panel Description

HP-IB. The 3781A accepts and supplies information via this rear-panel socket. The HP-IB facility can control all switches except POWER and LOCAL. The REMOTE, LOCAL, TALK, LISTEN and SRQ LEDs indicate the HP-IB status of the 3781A. The 3781A is designed to operate in the addressable mode. The HP-IB address is set by the rear-panel, dual-in-line ADDRESS switch. If no Controller is connected, the setting of this switch is immaterial.

### 3-10 3782A Error Detector CONTROLS, CONNECTORS AND INDICATORS

#### 3-11 Front-Panel Description

- A  $75\Omega$  DATA INPUT accepts signals and levels from the appropriate hierarchy levels, depending on the

position of the DATA INPUT switch (4). An LED above the input (1) is illuminated if data transitions are present. This input uses a  $75\Omega$  unbalanced BNC connector.

- B  $120\Omega$  DATA INPUT accepts signals and levels from the appropriate hierarchy levels (0.7 and 2Mb/s), depending on the position of the DATA INPUT switch (4). An LED above the input (3) is illuminated if data transitions are present. This input uses a  $120\Omega$  balanced 3-pin Siemens connector.
- C CLOCK MONITOR OUTPUT ECL signal is the recovered clock from the DATA INPUT signal (A) or (B), or the rear-panel BINARY CLOCK INPUT signal. This output signal is continuous.
- D DATA MONITOR OUTPUT ECL supplies the same data as that accepted by the DATA INPUT (A) or (B). The format of the output signal is binary NRZ with ECL levels.
- E PATTERN TRIG OUTPUT supplies one pulse every PRBS or WORD. The position of the rising edge of the trigger pulse is with respect to the DATA MONITOR OUTPUT. With PRBS, the trigger pulse is 1 bit before the start of longest run of ones (for  $2^{15} - 1$  and  $2^{23} - 1$ ) and zeros (for  $2^9 - 1$ ). With WORD, the trigger pulse is 2 bits before start of bit 1 of word segment A. The amplitude of the PATTERN TRIG OUTPUT signal is 1V pk and is a nominal  $50\Omega$  unbalanced signal.
- F ERROR OUTPUT supplies one pulse per error at a minimum amplitude of 1V pk-pk.
- 1  $75\Omega$  DATA INPUT LED illuminates if data transitions are present at the  $75\Omega$  DATA INPUT (A).
- 2 MON LED illuminates when the DATA INPUT switch (4) is in the MON mode.
- 3  $120\Omega$  DATA INPUT LED illuminates if data transitions are present at the  $120\Omega$  DATA INPUT (B).
- 4 DATA INPUT switch selects the bit rate with the appropriate interface voltage levels, depending on the digital hierarchical level to which the 3782A is connected. The bit rates available are 704, 2048, 8448 and 34368kb/s. The MON/TERM position toggles between the MONitor mode (ie additional gain available to compensate for protected monitor points) and TERMinated mode.
- 5 CODE switch selects either AMI or HDB3.

- 6 ZERO SUB/16-BIT WORD push-buttons have dual functions. When used in conjunction with the PRBS modes of the PATTERN switch (13), the push-buttons are used in the ZERO SUB mode. The number of zeros substituted in the PRBS may vary from 0 to 120 in steps of 8 – ie., cumulative selection of push-buttons. When used in conjunction with the 16-BIT WORD modes of the PATTERN switch (13) the push-buttons are used in the 16-BIT WORD mode. The 16 bit word is a serial combination of four 4-bit words A, B, C and D. The contents of the four bits in A, B, C and D are set by the push-buttons.
- 7 POWER switch activates the entire instrument by controlling the ac supply.
- 8 TALK LED (HP-IB function) indicates that the 3782A is able to pass information over the HP-IB.
- 9 REMOTE LED (HP-IB function) indicates that the 3782A is being controlled from an external source.
- 10 SRQ LED (HP-IB function) indicates that the 3782A is requesting service from the HP-IB.
- 11 LISTEN LED (HP-IB function) indicates that the 3782A is listening to information from the HP-IB.
- 12 LOCAL switch (HP-IB function) allows the 3782A to be switched from Remote to Local control (indicated by the REMOTE and LOCAL LEDs) except when a Local Lockout signal has been issued by the Controller. The LOCAL LED indicates that the 3782A is being controlled via the front panel.
- 13 PATTERN switch can be segmented into two groups – PRBS and WORD.

PRBS: the 3782A offers a choice of three PRBS modes:–  $2^9-1$  (511 bits),  $2^{15}-1$  (32767 bits) and  $2^{23}-1$  (8388607 bits). The PRBS patterns can have zero substitution superimposed when the ZERO SUB push-buttons (6) are set.

WORD: 16-BIT WORD – the 3782A offers a selection of 16-bit words. The 16-bit word is the serial combination of four 4-bit words A, B, C and D. Contents of A, B, C and D are set by the 16-BIT WORD push-buttons (6).

1111 – fixed pattern of all ones.

- 14 DATA/ $\overline{\text{DATA}}$  switch can invert the input data signal. Inversion occurs at the binary signal level.

- 15 MEASUREMENT MODE switch has two positions – depending on the measurement required. The measurements available are BIN ERRORS (binary errors) and CODE ERRORS.

**Binary Errors** are detected by closed-loop, bit-by-bit error detection at the binary level after interface decoding has been removed. Binary errors are detected in pseudo-random data sequences and fixed word patterns.

**Code Errors** are defined as follows:

AMI – a bi-polar violation is a code error.

HDB3 – two consecutive bi-polar violations with the same polarity.

Code errors can be measured on live traffic as well as on patterns generated by the 3781A. However, they only have significance for the section following the previous interface encoder.

- 16 SYNC switch selects the method of detecting loss of synchronisation and how a search for synchronisation will be initiated. When the SYNC switch is in the AUTO mode, a search for synchronism is automatically initiated. Pattern Sync loss will only be detected correctly if there are at least 30,000 clock periods in the selected gating period. In the MAN SYNC mode, automatic sync loss detection is removed. Pressing the MAN SYNC push-button (17) initiates a search for synchronism. Before full synchronism is achieved, Pattern Sync criteria must be achieved.

**Pattern Sync** is monitored by the 3782A. If pattern sync loss occurs (approx. 1000 errors in 30,000 clock periods) the PATTERN SYNC LOSS LED (22) illuminates. Pattern sync gain is achieved when there are  $<10$  errors in 300 clock periods.

- 17 This push-button, with the SYNC switch (16) in the MANUAL mode enables the operator to re-synchronize the 3782A.
- 18 The result display window gives an LED display of the measured errors. The five-digit LED display, with leading zero blanking, automatically changes to A.B  $10^{MN}$  format when a count of 99999 is exceeded. The display for error rate is formatted A.B.  $10^{-MN}$  (where M can be blank or 1).

At the end of the gating period, the display will automatically show the measurement result that has been selected by the DISPLAY MODE switch. Any of the four measurement results can be displayed by simply setting the DISPLAY MODE switch to



the appropriate position, as all four measurements are made simultaneously. This feature can be used irrespective of the selected gating period and does not affect the current measurement.

Besides displaying measurement results, the display can also be used to display the real-time clock. Also, the display will give a flashing single-digit error code, if the operator has inadvertently selected incompatible switch settings.

- 19 ERRORS LED, when illuminated, indicates that error pulses are being detected. Each error pulse is stretched to approximately 500ms.
- 20 AIS (Alarm Indication Signal) LED illuminates when an all ones signal is detected with a nominal error rate of  $<10^{-3}$ . The LED remains illuminated for at least 500ms.
- 21 DISPLAY MODE switch selects how the measured errors (binary or code) may be displayed. Four error modes are provided — ERROR RATE, ERROR COUNT, ERROR SECS or ERROR FREE SECS. The result is displayed, by LEDs, in the parameter display window (18). Note that for each measurement over a selected gating period, any one of the four modes may be selected to show the result i.e., all four calculations are made simultaneously and the processor displays the desired result.  
  
The only exception occurs when binary inputs are used. ERROR RATE is available only when the CLOCKS gating period is selected.
- 22 PATTERN SYNC LOSS LED, when illuminated, indicates that the local pattern reference has lost sync with the incoming pattern. This facility is used in conjunction with the SYNC switch (16). The LED remains illuminated for at least 500ms.
- 23 <100 ERRORS LED indicates that an Error Rate measurement result has been based on less than 100 errors i.e., the statistical variance in the result is greater than 10%.
- 24 GATING LED indicates that a measurement is in process.
- 25 GATING PERIOD switch selects the measurement gating period either in SECONDS, number of CLOCKS, MANUALLY or EXTERNALLY operated.
- 26 START push-button initiates a gating period, when the GATING PERIOD switch (25) is in the MAN mode. When the rear-panel REAL TIME CLOCK switch is set to VIEW/SET, the START push-button is used to set HOURS on the local time display.

- 27 STOP push-button terminates a gating period, when the GATING PERIOD switch (25) is in the MAN mode. When the rear-panel REAL TIME CLOCK switch is set to VIEW/SET, the STOP push-button is used to set MINUTES on the local time display. The seconds are set to zero when either push-button is pressed.

When the REAL TIME CLOCK switch is set to VIEW/SET, pressing both push-buttons (26) and (27) simultaneously holds the clock display — ready for initialization when the push-buttons are released.

### 3-12 Rear-Panel Description

BINARY DATA INPUT is an alternative data input to the 3782A, via the rear-panel BIN/TERNARY switch. The frequency range available is 1kb/s to 50Mb/s with a binary, TTL, NRZ format.

BINARY CLOCK INPUT is used to supply clock to the 3782A via the rear-panel BIN/TERNARY switch (when the BINARY DATA INPUT is used). The clock rate should be in the range 1kHz to 50MHz, with an TTL format.

EXT GATING INPUT. When the GATING PERIOD switch (25) is set to EXT, a high ECL logic level applied to the EXT GATING INPUT will initiate a gating period while a low ECL logic level will terminate the gating period.

HP-IB. The 3782A accepts and supplies information via this rear-panel socket. The HP-IB facility can control all switches except POWER and LOCAL. The REMOTE, LOCAL, TALK, LISTEN and SRQ LEDs indicate the HP-IB status of the 3782A.

The 3782A is designed to operate in two distinct modes — “Talk Only” and “Addressable”. The HP-IB address is set by the rear-panel, dual-in-line ADDRESS switch. The “Talk Only” mode allows the measurement results to be output to a peripheral device (such as a Printer or Cassette Recorder) connected in a “Listen” mode, when no Controller is connected.

BIN/TERNARY switch allows data to be input either in ternary format at the four hierarchy levels [via the front-panel inputs (A) or (B)] or alternatively via the BINARY CLOCK and DATA INPUTs on the rear panel.

RESULT PRINT THRESHOLD switch. At the end of each gating period, this switch (in conjunction with some software masks — see Section 3-31) governs whether measurement results are issued via the HP-IB connector. If the value set on the switch is 15

– threshold always satisfied (always prints). If set to 14 – threshold satisfied if one or more errors have occurred. If set to a value  $N$  (where  $0 \leq N \leq 13$ ) the answer will only be issued if the measured error rate during that gating period was worse than  $1.0 \times 10^{-N}$ .

**REAL TIME CLOCK switch.** When set to VIEW/SET, local time can be set via the STOP (27) and START (26) push-buttons and viewed on the parameter display (18). If a measurement is in progress, it will not be affected by setting the clock. When set to the NORMAL position, the parameter display and STOP and START push-buttons return to their normal functions, however, the processor continues to calculate the local time.

### 3-13 SWITCH-ON PROCEDURE

3-14 The 3781A and 3782A each require an ac power supply of 115V (+15%, -22%) or 230V (+10%, -18%) at 48 to 66Hz and each consume less than 150VA.

#### WARNING

**Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth grounded socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.**

**Only fuses with the rated current and specified type should be used. Do not use repaired fuses or short-circuited fuse-holders. To do so could cause a shock or fire hazard.**

#### CAUTION

**Before the instrument is switched on, it must be set to the voltage of the power source or damage to the instrument may result.**

**Fuses: 220/240V – 1.5AT (slow-blow)  
hp 2110-0304  
100/120V – 3AT (slow-blow)  
hp 2110-0381**

3-15 The instruments are ready for operation immediately after switch-on.

### 3-16 HP-IB MODES OF OPERATION



3-17 The 3781A is designed to operate in the Addressable mode and the 3782A is designed to operate in two distinct modes – Talk Only and Addressable. The HP-IB address is set by the rear-panel dual-in-line ADDRESS switch.

### 3-18 Operation in the Talk Only Mode (3782A only)

3-19 This is the simplest mode of operation and the mode used if no Controller is connected to the HP-IB. The front-panel controls are responsive and actively control the instrument. The 3782A automatically outputs messages relevant to its operation. For example, if an HP Model 5150A Option 001 Thermal Printer were connected to the 3782A it could be used to print-out measurement results. The 3782A rear-panel HP-IB ADDRESS switch must be set to Talk Only and any peripheral must be set to Listen Only. In this mode, the five HP-IB ADDRESS switches on the 3782A are used instead to control the format of the OUTPUT messages. They should normally all be set to the “1” position.

### 3-20 Operation in the Addressable Mode

3-21 The addressable mode of operation is more easily understood by imagining the concept that two front panels exist.

1. The ‘actual’ front panel.
2. A ‘remote’ front panel.

3-22 The instruments can be used to perform measurements under one of two modes of operation.

1. Under ‘local’ control – where the ‘actual’ front panel is responsive and used to control the instrument.
2. Under ‘remote’ control – where the ‘remote’ front panel is used to control the instrument and the ‘actual’ front panel is inoperative.

3-23 Programming codes sent by the Controller are used to set-up the ‘remote’ front panel. (At power-on, the instrument assumes the local state.) On going remote, the ‘remote’ front panel is initialized with the current switch settings of the ‘actual’ front panel.

### 3-24 PRINCIPAL FEATURES OF HP-IB OPERATION

1. Ability to overwrite a switch or push-button position by remote control.
2. Output results in one or all of the four display modes.
3. Flexibility and operational simplicity achieved using pre-programmed control masks.



4. HP-IB Bus Extenders and suitable modems may be used to increase the distance between instruments.
5. The current positions of all front and rear-panel switches (except push-buttons) or all remote switches and masks be issued.

### 3-25 IMPLEMENTATION OF HP-IB

3781A:

SH1 complete capability  
 AH1 complete capability  
 T6 basic talker, serial poll, unaddress if MLA  
 TE0 no capability  
 L4 basic listener, unaddress if MTA  
 LE0 no capability  
 SR1 complete capability  
 RL1 complete capability  
 PP0 no capability  
 DC1 complete capability  
 DT0 no capability  
 C0 no capability

3782A:

SH1 complete capability  
 AH1 complete capability  
 T5 basic talker, serial poll, talk only mode, unaddress if MLA  
 TE0 no capability  
 L4 basic listener, unaddress if MTA  
 LE0 no capability  
 SR1 complete capability  
 RL1 complete capability  
 PP0 no capability  
 DC1 complete capability  
 DT0 no capability  
 C0 no capability

### 3-26 REPERTOIRE OF REMOTE COMMANDS

3-27 The 'remote' commands require a code to be sent to the instruments from the HP-IB Controller. The format of this code is a two-character, upper or lower case mnemonic which specifies the action needed or the switch to be set. Sometimes the switch mnemonic is followed by a parameter which indicates the new position of the switch. For slide switches, this number is the position of the switch – starting with '1' at the left-hand side (see Figure 3-2).



Figure 3-2 Slide Switch Position Numbering

3-28 For rear-panel toggle switches, the "up" position has code '1' and the "down" position has code '2'.

3-29 Successive commands may be separated by a comma (,) semi-colon (;) colon (:) or space ( ). Commands may be sent either whilst gating or not gating. If commands contained in Paragraph 3-30 (1) or (2) are received whilst under 'local' control, they will be accepted but ignored.

3-30 The following remote commands are available:

1. Over-write a switch or push-button on the 'remote' front panel. Tables 3-1 and 3-2 give the switch mnemonics.

The following switches are *not* remotely controllable:

POWER (ON/OFF)  
 LOCAL (on front panel)  
 HP-IB ADDRESS (on rear-panel)  
 TALK ONLY/ADDRESSABLE (3782A only)  
 REAL-TIME CLOCK (3782A only)  
 LINE VOLTAGE SELECTOR

Table 3-1 3781A Switch Mnemonics

SWITCH NAME	MNEMONIC	PARAMETER RANGE
PATTERN	PTn	$1 \leq n \leq 9$
DATA OUTPUT	DOn	$1 \leq n \leq 6$
WORD A	WAn	$0000 \leq n \leq 1111$ (Binary)
WORD B	WBn	$0000 \leq n \leq 1111$ (Binary)
WORD C	WCn	$0000 \leq n \leq 1111$ (Binary)
WORD D	WDn	$0000 \leq n \leq 1111$ (Binary)
ZERO SUB (VALUE)	ZVn	$0 \leq n \leq 120$ (Divisible by 8)
ERROR ADD (FORMAT)	EFn	$1 \leq n \leq 2$
JITTER	JTn	$1 \leq n \leq 2$
CLOCK	CKn	$1 \leq n \leq 4$
ERROR ADD RATE	ERn	$1 \leq n \leq 3$
CODE	CDn	$1 \leq n \leq 2$
ERROR ADD SINGLE SHOT	ES	



Table 3-2 3782A Switch Mnemonics

SWITCH NAME	MNEMONIC	PARAMETER RANGE
PATTERN	PTn	$1 \leq n \leq 8$
WORD A	WAn	$0000 \leq n \leq 1111$ (Binary)
WORD B	WBn	$0000 \leq n \leq 1111$ (Binary)
WORD C	WCn	$0000 \leq n \leq 1111$ (Binary)
WORD D	WDn	$0000 \leq n \leq 1111$ (Binary)
ZERO SUB (VALUE)	ZVn	$0 \leq n \leq 120$ (Divisible by 8)
DATA/DATA	DDn	$1 \leq n \leq 2$
MEASUREMENT MODE	MMn	$1 \leq n \leq 2$
DISPLAY MODE	DMn	$1 \leq n \leq 4$
DATA INPUT	DIn	$1 \leq n \leq 6$
MON/TERM	MTn	$1 \leq n \leq 2$
SYNC	SYn	$1 \leq n \leq 2$
GATING PERIOD	GPn	$1 \leq n \leq 10$
BINARY/TERNARY INPUT	BTn	$1 \leq n \leq 2$
CODE	CDn	$1 \leq n \leq 2$
THRESHOLD	THn	$0 \leq n \leq 15$
MANUAL SYNC	MS	
START	SI	
STOP	SP	

2. Request that the instruments load the 'remote' switches and masks with data. The mnemonic is LD (load).

3. 3781A only. Request that the current jitter measurement display be issued in Controller format (ie in the form "+N.NNNNE+NN"). If the current display is blank, an out-of-range answer (" +9.9999E+99") is sent to the Controller. (The jitter measurement display takes a few seconds to stabilize after movement of the DATA OUTPUT, JITTER or CLOCK switches). The mnemonic is CA (current answer).

4. 3781A only. Request that the current status of the front-panel CLOCK TRANSITIONS PRESENT annunciator (LED) be issued. A single-byte reply is given.

Byte = 0, when LED is OFF.

Byte = 1, when LED is ON.

The mnemonic is QA (query annunciator).

5. 3782A only. Request that the current answer indicated by the DISPLAY MODE switch be issued. This command provides answers in addition to those provided by Masks 2 and 4 and can also provide answers while the instrument is gating. (For information on Masks, see Paragraph 3-31). Mask 1 controls the format – either in Controller format ("N.NNNNE±NN")

or Peripheral format, in which case, one of the following will be sent, depending on the position of the DISPLAY MODE switch.

1. ER N,NE-N  
< 100 ERRORS (sometimes)
2. EC NNNNN
3. ES NNNNN
4. FS NNNNN

If the current display is blank, or is used to display an erroneous switch position, an out-of-range answer (" +9.9999E + 99") is sent in Controller format or the message "NO ANSWER" is sent in Peripheral format.

The mnemonic is CA (current answer).

6. 3782A only. Request that the number of errors counted, up till the last error-second occurred, be issued. This command provides answers in addition to those provided by Mask 8. Mask 1 permits selection between Controller format and Peripheral format "EC (NNNNN)". The mnemonic is EC (error count).
7. 3782A only. Request that the current status of the front panel annunciators (LED's) be issued (except the ERRORS annunciator). A single byte reply is given. The meaning of each bit is given in Table 3-3.



Table 3-3 Bit Significance

BIT	MEANING
0	AIS
1	<i>not used</i>
2	PSL (Pattern Sync Loss)
3	<i>not used</i>
4	<100 Errors
5	Gating
6	75 $\Omega$ Data Input
7	120 $\Omega$ Data Input

If any bit = 0, the appropriate LED is OFF.

If any bit = 1, the appropriate LED is ON.

The mnemonic is QA (query annunciators).

8. 3782A only. Request that the internal clock of the 3782A be initialized. This command must be followed by a six-digit parameter. (The clock is set to the desired time by six digits.) For example, IC 235958 will set the clock to 23 hours, 59 minutes, 58 seconds.

The mnemonic is IC (initialize clock).

9. Request that the current status of all 'actual' front-panel and rear-panel switches (except push-buttons) and masks be issued. Sixteen bytes of data are output for the 3781A and thirty-eight bytes of data are output for the 3782A in response to this command.

The mnemonic is LA (learn actual).

10. Request that the current positions of all 'remote' switches and masks be issued. Sixteen bytes of data are output for the 3781A and thirty-eight bytes of data are output for the 3782A in response to this command.

The mnemonic is LR (learn remote).

11. Issue a signal to set 'Local Lockout'.

12. Issue a signal to clear 'Local Lockout'. (Note: it is implicit in HP-IB protocol that this command will also cause the instrument to go 'local'.)

13. Issue an HP-IB signal to cause the instruments to completely clear themselves and return to the power-on state (using Device Clear or Selected Device Clear). *It is recommended that every program used to remotely control these instruments starts with either of these commands.* After issuing either of these commands, the Controller must give the instruments time to react and settle. A wait of 0.5 second is recommended. The issue of either of these commands does not affect the setting of the 3782A real-time clock.

14. Request that the cyclic redundancy check word (CRC word) of each part of the firmware be issued. This allows the version of firmware installed to be confirmed without access to the interior of the instrument. It also permits the version to be remotely interrogated in an automated system. The firmware part number is represented by parameter number n, in the range  $1 \leq n \leq 3$  for the 3781A and  $1 \leq n \leq 5$  for the 3782A. A four-byte hexadecimal CRC word is issued in response to each command. The set of two, or five, CRC words completely define the firmware installed in the 3781A and 3782A respectively.

The mnemonic is QF (query firmware) followed by the parameter number.

### 3-31 CONTROLLING MASKS

3-32 To permit flexibility in the use of these instruments many of the important operating parameters are governed by Masks. At power-on, these masks are given default values — as specified in Tables 3-4 and 3-5. These default values may be overwritten at any time for the 3781A or, in the 'local' and 'remote' states of the Addressable mode for the 3782A. (For the 3782A only, in the Talk Only mode, five of the masks are controlled by the five rear-panel HP-IB ADDRESS switches.) The masks are programmed by the mnemonic MK followed by the parameter number.

**Table 3-4 3781A Mask Default Values**

Mask Number	Meaning	Parameter Number	Default Value
1	Issue EOI concurrent with terminator	1	2
	Do not issue EOI concurrent with terminator	2	
2	Do not SRQ on command Syntax Error	3	4
	SRQ on command Syntax Error	4	
3	Do not SRQ on command Syntax OK	5	5
	SRQ on command Syntax OK	6	
4	Do not SRQ when "LOCAL" pushbutton pressed	7	7
	SRQ when "LOCAL" pushbutton pressed.	8	

**Table 3-5 3782A Mask Default Values**

Mask Number	Meaning	Parameter Number	Default Value	
			Talk Only	Addressable
1	<b>MESSAGE SET</b> Issue answers in Peripheral format. Issue answers in Controller format.	1	1	2
		2		
2	Do not issue answer at end of Gating Period. Issue answer at end of Gating Period only if rear-panel RESULT PRINT THRESHOLD switch is satisfied.	3	4	3
		4		
3	Do not issue general control messages. Issue general control messages.	5	6	5
		6		
4	Issue four answers at end of Gating Period. (see Note 2). Issue just the answer indicated by DISPLAY MODE switch at end of Gating Period.	7	see Note 1	8
		8		
5	Do not prefix messages with Time. Prefix messages with Time.	9	see Note 1	9
		10		
6	Use (,) as message terminator. Use CR/LF as message terminator.	11	see Note 5	12
		12		
7	Issue EOI concurrent with terminator. Do not issue EOI concurrent with terminator.	13	see Note 1	14
		14		
8	Do not issue Error-Second messages. Issue Error-Second messages.	15	see Note 1	15
		16		
9	Do not prefix Error-Rate answers in Controller format with status of "< 100 ERRORS" LED. Prefix Error-Rate answers in Controller format with status of "< 100 ERRORS" LED (see Note 3)	17	17	17
		18		
10	<b>SERVICE REQUEST SET</b> Do not SRQ when Error-Second occurs. SRQ when Error-Second occurs.	19	19	19
		20		
		21	21	22
		22		
		23	23	23
		24		



Table 3-5 3782A Mask Default Values (continued)

Mask Number	Meaning	Parameter Number	Default Value	
			Talk Only	Addressable
13	Do not SRQ if Gating Period ends because of data integrity loss.	25	25	25
	SRQ if Gating Period ends because of data integrity loss.	26		
14	Do not SRQ if Gating Period ends because of an invalid switch movement.	27	27	27
	SRQ if Gating Period ends because of an invalid switch movement.	28		
15	Do not SRQ on command Syntax Error.	29	29	30
	SRQ on command Syntax Error.	30		
16	Do not SRQ on command Syntax OK.	31	31	31
	SRQ on command Syntax OK.	32		
17	Do not SRQ on loss/gain of data integrity.	33	33	33
	SRQ on loss/gain of data integrity.	34		
18	Do not SRQ after each 24-hour period elapsed on internal clock.	35	35	35
	SRQ after each 24-hour period elapsed on internal clock;	36		
19	Do not SRQ when "LOCAL" pushbutton pressed.	37	37	37
	SRQ when "LOCAL" pushbutton pressed.	38		
<b>RESTART SET</b>				
20	Automatically restart repetitive gating.	39	39	40
	Automatically restart repetitive gating unless rear panel RESULT PRINT THRESHOLD switch satisfied.	40		
21	Do not restart gating following loss/gain of data integrity.	41	42	42
	Automatically restart gating following loss/gain of data integrity.	42		
22	Do not hold-off automatic restart until output buffer empty.	43	44	44
	Hold-off automatic restart until output buffer empty.	44		
23	Do not hold-off automatic restart until SRQ buffer empty.	45	46	46
	Hold-off automatic restart until SRQ buffer empty.	46		

Note 1: Talk Only values of Masks 4, 5, 7 and 8 are controlled by bits 0, 1, 3 and 4 respectively, of the rear-panel HP-IB ADDRESS switch. Position "1" of the switch selects the *even* value of parameter number.

Note 2: When the GATING PERIOD switch is set to SECONDS, MINUTES and HOUR, EXTERNAL, or MANUAL and the BINARY INPUTS are used, only three answers are issued.

Note 3: If the "<100 ERRORS" annunciator is OFF, Error-Rate answers are prefixed with character "0". If annunciator is ON, answers are prefixed with character "1". If Mask 5 is set to prefix messages with Time, the Time message comes before the "<100 ERRORS" annunciator character.

Note 4: "NORMAL END" means a non-abortive end, with the GATING PERIOD switch set to SECONDS, CLKS, or EXTERNAL.

Note 5: Talk Only value of Mask 6 is controlled by an internal link on 3782A Assembly A11.



### 3-33 RESULT PRINT THRESHOLD SWITCH (3782A only)

3-34 At the end of each Gating Period, the rear-panel RESULT PRINT THRESHOLD switch (in conjunction with Masks 2, 12 and 20) governs whether:

- (a) answers are issued,
- (b) an SRQ is generated,
- (c) another Gating Period will start automatically.

The sixteen positions of the RESULT PRINT THRESHOLD switch govern whether the threshold is satisfied at the end of a Gating Period according to Table 3-6.

*If the BINARY INPUT is used with the GATING PERIOD switch set to SECONDS, EXTERNAL or MANUAL, an ERROR RATE answer is not available and a switch setting of 0 to 13 is treated as though a switch setting of 14 had been selected.*

### 3-35 REPERTOIRE OF MESSAGES (3782A only)

3-36 The 3782A is designed to issue a number of messages during the progress of a measurement. Each message is controlled by one or more Masks. Table 3-7 lists the messages and appropriate controlling masks.

**Table 3-6 Result-Print Threshold**

Switch Position	Description
$0 \leq N \leq 13$	Threshold satisfied only if ERROR RATE is worse than $1.0E-N$ . (If the GATING PERIOD switch is set to SECONDS, MINUTES and Hour, EXTERNAL or MANUAL and the BINARY INPUTs are used, an Error-Rate answer is not available. In this case, a switch position of 0 through 13 is treated as though position 14 has been selected.)
$N = 14$	Threshold satisfied only if one or more errors have occurred.
$N = 15$	Threshold always satisfied.

**Table 3-7 Output Messages**

Message	Controlling Mask (s)
An Answer	1,2,4
ERROR SECOND	8
"NO ANSWER" (in response to CA, when no answer available — Peripheral format)	1
" +9.9999E + 99" (in response to CA, when no answer available — Controller format)	1
" < 100 ERRORS"	1,2,4
"START"	3
"STOP"	3
"RESTART"	3
"DATA LOSS"	3
"AIS"	3
"PATTERN LOSS"	3
"RECOVERY"	3
"RUN ABORT"	3
"DAY N"	3
"POWER ON"	3
TIME (as prefix to message)	5





### 3-37 TERMINATION OF A BUFFER (3782A only)

3-38 Sometimes an instrument having an internal input buffer (eg the HP Model 9875A Cartridge Tape Unit) is used to receive the 3782A output messages. At the end of a sequence of measurements, and before powering down, any partially-filled input buffer needs to be written onto tape. This is achieved using a CR/LF code. A CR/LF will be issued if the 3782A "STOP" pushbutton is pressed (either manually or remotely) while Mask 6 is set to use the code "," as message terminator and the rear-panel REAL-TIME CLOCK switch is set to NORMAL.

### 3-39 SERVICE REQUESTS

3-40 Both instruments are designed to issue a service request (SRQ) when service from the Controller is required.

Programmable masks govern whether each request is generated.

3-41 It is possible for a service request to be generated before the Controller has had time to service any previous requests. In such instances, the instruments stack the requests in an orderly manner. It makes good programming sense to keep the length of this stack as short as possible by promptly responding to requests and not issuing further commands until the stack is empty. (However, it is not mandatory for the request to be serviced immediately if at all.) An instrument should not be serially polled within 20 milliseconds of a previous serial poll of that instrument.

### 3-42 REPERTOIRE OF SERVICE REQUESTS

3-43 Tables 3-8 and 3-9 list the service request codes that are used to indicate the reason for service. The mask number that controls each service request is also given.

**Table 3-8 3781A Service Request Codes**

Octal	Code		Meaning	Controlling Mask Number
	Decimal	Hex		
001	1	01	NEUTRAL — ALL OK	
100	64	40	Command Syntax Error In Line	2
101	65	41	Command Syntax of Line OK	3
102	66	4R	"LOCAL" push-button pressed	4

**Table 3-9 3782A Service Request Codes**

Octal	Code		Meaning	Controlling Mask Number
	Decimal	Hex		
001	1	01	NEUTRAL — ALL OK	
100	64	40	An Error-Second has occurred.	10
101	65	41	Cannot start — "ERROR 1" displayed.	11
104	68	44	Cannot start — "ERROR 4" displayed.	11
105	69	45	End of Gating Period — Normal.	12
106	70	46	End of Gating Period — Data Integrity Loss.	13
107	71	47	End of Gating Period — Invalid Switch Movement.	14
110	72	48	Command Syntax Error in Line.	15
111	73	49	Command Syntax of Line OK.	16
112	74	4A	Data Loss has occurred.	17
113	75	4B	AIS has occurred.	17
115	77	4D	Pattern Sync Loss has occurred.	17
116	78	4E	Data integrity regained.	17
117	79	4F	A further 24-hours has elapsed on internal real-time clock.	18
120	80	50	"LOCAL" pushbutton pressed.	19



### 3-44 LOCAL Push-button

3-45 The LOCAL push-button is situated on the front-panel of both instruments. The function of this control is to cause either instrument to return to the "Local" state (manually controllable). The Controller can, however, issue a Local Lockout command in which case the LOCAL push-button becomes inoperative. (In the 3782A, this control is functionally inoperative in the Talk Only mode.)

### 3-46 Internal Real-Time Clock (3782A only)

3-47 The 3782A has a built-in, crystal-controlled, real-time clock. The instrument can be programmed to prefix messages with the time from this internal clock. The format of this message is "HH-MM-SS". Peripheral devices having no internal clock of their own (eg the HP Model 9875A Cartridge Tape Unit) can thus receive timed messages from the 3782A.

3-48 The clock can be initialized in one of three ways:

1. At device power-on, the clock is set to zero.
2. Under "Local" control (either in the Talk Only or Addressable modes) the rear-panel REAL-TIME CLOCK switch can be set to VIEW/SET. The front-panel START and STOP push-buttons now take the subsidiary roll of fast advance of Hours and Minutes respectively. The main LED display window simultaneously shows the time in hours and minutes. If both push-buttons are held down together, the internal clock is held at the current time.
3. Under "Remote" control, using the command "IC".

Initializing the clock sets the day count to '1' and (for steps 1 and 2 only) sets the seconds count to zero.

3-49 Whenever the clock rolls over, after each 24-hour period, an output message gives the day count and an SRQ is generated under control of the programmable masks. The total range of the clock is 99 days, 23 hours, 59 minutes and 59 seconds.

### 3-50 USING THE HP 37201A BUS EXTENDER

3-51 The HP Model 37201A Bus Extender and suitable modems may be used to increase the distance between instruments. However, these long-distance communication paths must remain connected for the entire period that the instruments are expected to function remotely. Remember, that for each "local" 37201A Bus Extender used, only one "remote" 37201A Bus Extender and HP-IB instrument cluster can be active at any one time.

### 3-52 DEFINITION OF 'LEARN' TRANSFER

3-53 In response to a Learn Actual (LA) or Learn Remote

(LR) command, the instruments output the settings of the switches and masks in a compact form. It is not necessary for the operator to know the internal format of this information, as its normal use is to allow a subsequent load instruction to re-load the switches and masks with their earlier values. However, Tables 3-10 and 3-11 define the structures — should a need arise to know the internal structure.

3-54 Each controllable switch is allocated the bits given in Tables 3-10 and 3-11 (undefined bits are not necessarily output as zero). Information output signal comprises 16 bytes for the 3781A and 38 bytes for the 3782A. All slide switch codes start with zero at the left-hand side.

**Table 3-10 3781A Response Codes**

Switch	Byte Number	BITS
PATTERN	1	0-3
DATA OUTPUT	5	0-2
WORD A	8	0-2, 4
WORD B	9	0-2, 4
WORD C	10	0-2, 4
WORD D	11	0-2, 4
ZERO SUB (VALUE)	12	0-2, 4
CODE	2	0
ERROR ADD (FORMAT)	6	0
JITTER	4	0
CLOCK	3	0-1
ERROR ADD (RATE)	7	0-1
MASKS (1 → 4)	13 → 16	0

**Table 3-11 3782A Response Codes**

Switch	Byte Number	BITS
PATTERN	1	0-2
WORD A	10	0-2, 4
WORD B	11	0-2, 4
WORD C	12	0-2, 4
WORD D	13	0-2, 4
ZERO SUB (VALUE)	14	0-2, 4
MON/TERM	15	0
CODE	2	0
DATA/DATA	2	1
MEASUREMENT MODE	4	0
DISPLAY MODE	6	0-1
DATA INPUT	3	0-2
SYNC	8	0
GATING PERIOD	7	0-3
BINARY/TERNARY INPUT	3	4
RESULT PRINT THRESHOLD	9	0-2, 4
REAL-TIME CLOCK	5	0
MASKS (1 → 23)	16 → 38	0

### 3-55 OPERATORS CHECKS

3-56 The Operators Checks allow the operator to check the basic functions of the instruments prior to use. (A complete specification check is given in Section IV of the Service Manuals.)

### 3-57 BASIC FUNCTIONAL CHECKS

1. Ensure the mains selector setting and fuse rating are correct for the power line in use (see Section II). Connect instruments to mains supply.
2. Switch-on 3781A. All front-panel LEDs should illuminate (except for LOCAL LED). After a brief period, all LEDs should extinguish and the LOCAL LED illuminate. (Ignore JITTER display reading.)
3. Set the 3782A rear-panel ADD/TALK ONLY switch to TALK ONLY. Switch-on 3782A. All front-panel LEDs should illuminate (except for LOCAL LED). The ERROR LED will illuminate briefly. After a brief period, all LEDs should extinguish except for the TALK and PATTERN SYNC LOSS LEDs, and possibly the <100 ERRORS LED. The LOCAL LED should illuminate. The display window should indicate a flashing "7".
4. Press the 3782A LOCAL push-button and the flashing "7" should be removed from the display.
5. Set all 3781A front-panel switches to the left-hand side except for:
 

CLOCK . . . . . INT  
ERROR ADD . . . . . SINGLE/OFF
6. Set all 3782A front-panel switches to the left-hand side except for:
 

GATING PERIOD . . . . .  $10^6$  CLKS
7. Set the 3782A rear-panel switches as follows:
 

REAL TIME CLOCK . . . . . VIEW/SET  
BIN I/P/TERNARY I/P . . . . . TERNARY I/P
8. Set the local time on the 3782A display using the HRS and MINS push-buttons.
9. Set the 3782A rear-panel REAL TIME CLOCK switch to NORMAL. The display should be blank.
10. Connect the 3781A  $75\Omega$  DATA OUTPUT to the 3782A  $75\Omega$  DATA INPUT. Connect the 3781A  $120\Omega$  DATA OUTPUT to the 3782A  $120\Omega$  DATA INPUT using a balanced 3-pin Siemens audio cable.
11. Check that the 3782A  $75\Omega$  DATA INPUT LED is illuminated.
12. Set the 3781A ERROR ADD switch to 1 in  $10^5$  and, after a brief period, check that the 3782A display reads " $1.0 \times 10^{-5}$ " with the ERRORS and <100 ERRORS LEDs illuminated and the GATING LED flashing slowly.
13. Set the 3781A ERROR ADD switch to CODE and check that the 3782A display reads "0.0" with the <100 ERRORS LED illuminated and the GATING LED flashing slowly.
14. Set the 3782A MEASUREMENT MODE switch to CODE ERRORS and check the 3782A display reads " $1.0 \times 10^{-5}$ " with the GATING LED flashing.
15. Set the 3782A DISPLAY MODE switch to ERROR COUNT and the GATING PERIOD switch to 1 SEC.
16. Set the 3781A DATA OUTPUT and 3782A DATA INPUT switches to 0.7Mb/s (lower switch position) and check that the  $120\Omega$  DATA INPUT LED illuminates.
17. Set the 3781A DATA OUTPUT and 3782A DATA INPUT switches according to the settings contained in Table 3-12, and check the 3782A parameter display reading. Check that the GATING LED is flashing. (Wait until the end of the gating period before consulting Table 3-12).

**Table 3-12 Display Readings**

DATA INPUT/OUTPUT switch settings (Mb/s)	3782A Parameter Display Reading
0.7	7 or 8
0.7 (lower position)	7 or 8
2	20 or 21
2 (lower position)	20 or 21
8	84 or 85
34	343, 344 or 345

18. Set the 3782A GATING PERIOD switch to MAN and the 3781A ERROR ADD switch to SINGLE/OFF. Press the 3782A START push-button and check the 3782A parameter display reads "0" with the GATING LED illuminated.
19. Press the 3781A SINGLE ERROR push-button several times and check the 3782A parameter display increments in unit steps at each press and the ERRORS LED illuminates momentarily.
20. Set the 3781A ERROR ADD switch to BIN and the 3782A MEASUREMENT MODE switch to BIN ERRORS.
21. Set the 3781A PATTERN switch to 1111/AIS and check the 3782A AIS LED illuminates.
22. Set the 3782A PATTERN switch to 1111 and check the 3782A AIS LED extinguishes.
23. Press the 3782A START push-button and press the 3781A SINGLE ERROR push-button several times. Check that the 3782A parameter display increments in unit steps at each press and the ERROR LED illuminates momentarily.
24. Set the 3782A PATTERN switch to  $2^{23}-1$ .
25. Set the 3781A 16-BIT WORD segments A, B, C and D to 1111 using the BIT 1 to BIT 4 push-buttons.
26. Check the 3782A AIS LED is illuminated.
27. Set the 3781A ERROR ADD switch to 1 in  $10^3$  and set the 3781A PATTERN switch to  $2^{23}-1$ .
28. Set the 3782A DISPLAY MODE switch to ERROR RATE and the GATING PERIOD switch to  $10^6$  CLKS. Check the 3782A parameter display reads " $1.0 \cdot 10^{-3}$ ".
29. Set the 3781A and 3782A PATTERN switches to  $2^{15}-1$  and check the 3782A parameter display reads " $1.0 \cdot 10^{-3}$ " with the GATING LED flashing.
30. Set the 3782A DATA/DATA switch to DATA and check the PATTERN SYNC LOSS LED illuminates. Reset the 3782A DATA/DATA switch to DATA.
31. Set the 3781A CODE switch to HDB3 and check the 3782A PATTERN SYNC LOSS LED illuminates.
32. Set the 3782A CODE switch to HDB3 and check the 3782A parameter display reads " $1.0 \cdot 10^{-3}$ " with the GATING LED flashing.
33. Set the 3782A SYNC switch to MAN, and the 3781A and 3782A PATTERN switches to  $2^9-1$ . Check the 3782A parameter display reads " $5.0 \cdot 10^{-1}$ " with the GATING LED flashing.
34. Press the 3782A SYNC push-button and check the 3782A parameter display reads " $1.0 \cdot 10^{-3}$ ".
35. Set the 3781A and 3782A ZERO SUB push-buttons according to Table 3-13 and check the display is as shown, with the GATING LED flashing.
36. Set the 3781A and 3782A ZERO SUB push-buttons according to Table 3-14 and check the display is as shown, with the GATING LED flashing.
37. Set the 3782A SYNC switch to AUTO and check the 3782A PATTERN SYNC LOSS LED illuminates. (Ignore the parameter display reading.)
38. Set the 3782A rear-panel BIN I/P/TERNARY I/P switch to BIN I/P and connect the 3781A CLOCK MONITOR OUTPUT to the 3782A rear-panel CLOCK INPUT.
39. Set the 3782A PATTERN switch to 16-BIT WORD A and check the 3782A parameter display reads "0.0" with the GATING LED flashing.

**Table 3-13 ZERO SUB Settings**

Instrument	ZERO SUB push-buttons				3782A Display Reading
	8	16	32	64	
3781A	ON	ON	ON	OFF	" $3.2 \cdot 10^{-2}$ "
3782A	ON	ON	OFF	ON	

**Table 3-14 ZERO SUB Settings**

Instrument	ZERO SUB push-buttons				3782A Display Reading
	8	16	32	64	
3781A	ON	ON	ON	OFF	" $3.4 \cdot 10^{-2}$ "
3782A	ON	ON	OFF	OFF	

### 3-58 ERROR CODES (3782A only)

3-59 Certain combinations of switch positions are invalid. These invalid positions generate an error code which flashes in the left-hand position of the main LED display window. The significance of these codes is given in the Table 3-15.

**Table 3-15 Error Code Description**

Error Code	Meaning
1	ERROR RATE display not permitted for BINARY INPUTS when GATING PERIOD switch set to SECONDS, MINUTES, HOURS, EXTERNAL or MANUAL.
4	CODE ERROR measurements not permitted for BINARY INPUTS.
5	Code "31" not permitted for HP-IB Address.
6	'Talk Only' mode not permitted when Controller connected.
7	Instrument has suffered power interrupt and been powered-up. This code is cancelled by movement of any switch or upon receipt of a 'remote' command.

### 3-60 OPERATORS MAINTENANCE

3-61 Operators Maintenance consists of replacing defective fuses and cleaning the air filter. These items are discussed in the following paragraphs.

#### WARNING

**It is important that the following maintenance procedures be executed according to the**

**recommended schedule to retain the safety features which have been designed into the instrument.**

### 3-62 Fuses



3-63 The ac line fuse, located at the rear of the instrument may be replaced by the operator. The ac line cord should be disconnected from the power source and the other end disconnected from the instrument. With the power cord removed, the fuse compartment may be opened. The fuse is removed by unscrewing the fuse compartment end cap. For detailed information on fuse replacement and values, refer to Section II

### 3-64 Air Filter



3-65 The fan has a filter attached from the outside, for ease of cleaning and replacement. This filter should be removed and cleaned at intervals of approximately one month, depending on the environment. To service the filter, remove the four screws holding the filter to the rear panel.

#### WARNING

**The instrument should not be operated with the air filter removed and the fan blades exposed.**

3-66 Wash the filter mesh in clean soapy water, rinse thoroughly and dry before refitting, or, replace the filter with Part Number 03762-60040.



# SALES & SUPPORT OFFICES

Arranged alphabetically by country



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Keithstrasse 2-4  
D-1000 BERLIN 30  
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Hewlett-Packard GmbH  
Technisches Büro Böblingen  
Herrenberger Strasse 110  
D-7030 BOBLINGEN  
Tel: (07031) 667-1  
Telex: 07265739 bbn or 07265743  
A,C,M,CP,E,MP,P

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Technisches Büro Düsseldorf  
Emanuel-Leutze-Strasse 1  
D-4000 DUSSELDORF  
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Hewlett-Packard GmbH  
Vertriebszentrale Frankfurt  
Berner Strasse 117  
Postfach 560 140  
D-6000 FRANKFURT 56  
Tel: (0611) 50-04-1  
Telex: 04 13249 hpffm d  
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Hewlett-Packard GmbH  
Technisches Büro Hamburg  
Kapstadttring 5  
D-2000 HAMBURG 60  
Tel: (040) 63804-1  
Telex: 21 63 032 hphh d  
A,C,M,CP,E,MS,P

Hewlett-Packard GmbH  
Technisches Büro Hannover  
Am Grossmarkt 16  
D-3000 HANNOVER 91  
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Telex: 092 3259  
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Hewlett-Packard GmbH  
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Rosslauer Weg 2-4  
D-6800 MANNHEIM  
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Telex: 0462105  
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Technisches Büro Neu Ulm  
Messerschmittstrasse 7  
D-7910 NEU ULM  
Tel:  
Telex:  
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Neumeyerstrasse 90  
D-8500 NÜRNBERG  
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Telex: 0623 860  
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Hewlett-Packard GmbH  
Technisches Büro München  
Eschenstrasse 5  
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Navigation Road  
ALTRINCHAM  
Cheshire WA14 1NU  
Tel: (061) 928-6422  
Telex: 668068  
A,C,E,M

Hewlett-Packard Ltd.  
Oakfield House, Oakfield Grove  
Clifton  
BRISTOL BS8 2BN  
Tel: 36806  
Telex: 444302  
P

Hewlett-Packard Ltd.  
14 Wesley Street  
CASTLEFORD  
Yorkshire WF10 1AE  
Tel: (0977) 550016  
Telex: 5557355  
C

Hewlett-Packard Ltd.  
Fourier House  
257-263 High Street  
LONDON COLNEY  
Herts., AL2 1HA  
Tel: (0727) 24400  
Telex: 1-8952716  
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Hewlett-Packard Ltd.  
Tradax House, St. Mary's Walk  
MAIDENHEAD  
Berkshire, SL6 1ST  
Tel: (0628) 39151  
E,P

Hewlett-Packard Ltd.  
308/314 Kings Road  
READING, Berkshire  
Tel: 61022  
Telex: 84-80-68  
C,M,P

Hewlett-Packard Ltd.  
Quadrangle  
106-118 Station Road  
REDHILL, Surrey  
Tel: (0737) 68655  
Telex: 947234 C,E

Hewlett-Packard Ltd.  
Westminster House  
190 Stratford Road  
SHIRLEY, Solihull  
West Midlands B90 3BJ  
Tel: (021) 7458800  
Telex: 339105  
C

Hewlett-Packard Ltd.  
King Street Lane  
WINNERSH, Wokingham  
Berkshire RG11 5AR  
Tel: (0734) 784774  
Telex: 847178  
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## GREECE

Kostas Karayannis  
8 Omirou Street  
ATHENS 133  
Tel: 32-30-303, 32-37-371  
Telex: 21 59 62 RKAR GR  
E,M,P

"Plaiso"  
G. Gerados  
24 Stournara Street  
ATHENS  
Tel: 36-11-160  
Telex: 21 9492  
P

## GUATEMALA

IPESA  
Avenida Reforma 3-48  
Zona 9  
GUATEMALA CITY  
Tel: 316627, 314786, 664715  
Telex: 4192 Teletro Gu  
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## HONG KONG

Hewlett-Packard Hong Kong, Ltd.  
G.P.O. Box 795  
5th Floor, Sun Hung Kai Centre  
30 Harbour Road  
HONG KONG  
Tel: 5-8323211  
Telex: 66678 HEWPA HX  
Cable: HP ASIA LTD Hong Kong  
E,CP,P

Schmidt & Co. (Hong Kong) Ltd.  
Wing On Centre, 28th Floor  
Connaught Road, C.  
HONG KONG  
Tel: 5-455644  
Telex: 74766 SCHMX HX  
A,M

## ICELAND

Elding Trading Company Inc.  
Hafnarvölli-Tryggvagotu  
P.O. Box 895  
IS-REYKJAVIK  
Tel: 1-58-20, 1-63-03  
M

## INDIA

Blue Star Ltd.  
Bhavdeep  
Stadium Road  
AHMEDABAD 380 014  
Tel: 42932  
Telex: 012-234  
Cable: BLUEFROST  
E

Blue Star Ltd.  
11 Magarath Road  
BANGALORE 560 025  
Tel: 55668  
Telex: 0845-430  
Cable: BLUESTAR  
A,C,M,C,E

Blue Star Ltd.  
Band Box House  
Prabhadevi  
BOMBAY 400 025  
Tel: 422-3101  
Telex: 011-3751  
Cable: BLUESTAR  
A,M

Blue Star Ltd.  
Sahas  
414/2 Vir Savarkar Marg  
Prabhadevi  
BOMBAY 400 025  
Tel: 422-6155  
Telex: 011-4093  
Cable: FROSTBLUE  
A,C,M,C,E,M

Blue Star Ltd.  
7 Hare Street  
CALCUTTA 700 001  
Tel: 12-01-31  
Telex: 021-7655  
Cable: BLUESTAR  
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Blue Star Ltd.  
Meenakshi Mandiram  
XXXV/1379-2 M. G. Road  
COCHIN 682-016  
Tel: 32069  
Telex: 085-514  
Cable: BLUESTAR  
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Blue Star Ltd.  
133 Kodambakkam High Road  
MADRAS 600 034  
Tel: 82057  
Telex: 041-379  
Cable: BLUESTAR  
A,M

Blue Star Ltd.  
Bhandari House, 7th/8th Floors  
91 Nehru Place  
NEW DELHI 110 024  
Tel: 682547  
Telex: 031-2463  
Cable: BLUESTAR  
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Tel: 70126  
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Cable: BLUEFROST  
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Blue Star Ltd.  
T.C. 7/603 Poornima  
Maruthankuzhi  
TRIVANDRUM 695 013  
Tel: 65799  
Telex: 0884-259  
Cable: BLUESTAR  
E

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BERCA Indonesia P.T.  
P.O.Box 496/Jk1.  
Jin. Abdul Muis 62  
JAKARTA  
Tel: 373009  
Telex: 31146 BERSAL IA  
Cable: BERSAL JAKARTA  
A,C,E,M,P

BERCA Indonesia P.T.  
P.O. Box 174/Sby.  
J.L. Kutei No. 11  
SUBAEE-SURABAYA  
Tel: 68172  
Telex: 31146 BERSAL SD  
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Hewlett-Packard Trading S.A.  
Mansoor City 9B/3/7  
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Tel: 551-49-73  
Telex: 2455 HEPAIRAQ IK  
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Clanwilliam Court  
Lower Mount Street  
DUBLIN 2, Eire  
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Telex: 30439  
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Cardiac Services Ltd.  
Kilmore Road  
Arlane  
DUBLIN 5, Eire  
Tel: (01) 351820  
Telex: 30439  
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**Electronics Engineering Division**  
**Motorola Israel Ltd.**  
 16 Kremenetski Street  
 P.O. Box 25016  
**TEL-AVIV 67899**  
 Tel: 338973  
 Telex: 33569 Motil IL  
 Cable: BASTEL Tel-Aviv  
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**ITALY**

Hewlett-Packard Italiana S.p.A.  
 Traversa 99C  
 Giulio Petrone, 19  
 I-70124 **BARI**  
 Tel: (080) 41-07-44  
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Hewlett-Packard Italiana S.p.A.  
 Via Martin Luther King, 38/111  
 I-40132 **BOLOGNA**  
 Tel: (051) 402394  
 Telex: 511630  
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Hewlett-Packard Italiana S.p.A.  
 Via Principe Nicola 43G/C  
 I-95126 **CATANIA**  
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 Telex: 970291  
 C,P

Hewlett-Packard Italiana S.p.A.  
 Via G. Di Vittorio 9  
 I-20063 **CERNUSCO SUL NAVIGLIO**  
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 Telex: 334632  
 A,CM,CP,E,MP,P

Hewlett-Packard Italiana S.p.A.  
 Via Nuova san Rocco A  
 Capodimonte, 62/A  
 I-80131 **NAPOLI**  
 Tel: (081) 7413544  
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Hewlett-Packard Italiana S.p.A.  
 Viale G. Modugno 33  
 I-16156 **GENOVA PEGLI**  
 Tel: (010) 68-37-07 E,C  
 Hewlett-Packard Italiana S.p.A.  
 Via Turazza 14  
 I-35100 **PADOVA**  
 Tel: (49) 664888  
 Telex: 430315  
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Hewlett-Packard Italiana S.p.A.  
 Viale C. Pavese 340  
 I-00144 **ROMA**  
 Tel: (06) 54831  
 Telex: 610514  
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 Corso Giovanni Lanza 94  
 I-10133 **TORINO**  
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 Telex: 221079  
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**JAPAN**

Yokogawa-Hewlett-Packard Ltd.  
 Inoue Building  
 1348-3, Asahi-cho  
**ATSUGI**, Kanagawa 243  
 Tel: (0462) 24-0451  
 CM,C\*,E  
 Yokogawa-Hewlett-Packard Ltd.  
 3-30-18 Tsuruya-cho  
 Kanagawa-ku, Yokohama-Shi  
**KANAGAWA**, 221  
 Tel: (045) 312-1252  
 Telex: 382-3204 YHP YOK  
 CM,CS,E

Yokogawa-Hewlett-Packard Ltd.  
 Sannomiya-Daichi Seimei-Bldg. 5F  
 69 Kyo-Machi Ikuta-Ku  
**KOBE CITY** 650 Japan  
 Tel: (078) 392-4791  
 C,E

Yokogawa-Hewlett-Packard Ltd.  
 Kumagaya Asahi Yasoji Bldg 4F  
 4-3 Chome Tsukuba  
**KUMAGAYA**, Saitama 360  
 Tel: (0485) 24-6563  
 CM,CS,E

Yokogawa-Hewlett-Packard Ltd.  
 Mito Mitsui Building  
 4-73, San-no-maru, 1-chome  
**MITO**, Ibaragi 310  
 Tel: (0292) 25-7470  
 CM,CS,E

Yokogawa-Hewlett-Packard Ltd.  
 Sumitomo Seimei Bldg.  
 11-2 Shimo-sasajima-cho  
 Nakamura-ku  
**NAGOYA**, Aichi 450  
 Tel: (052) 581-1850  
 CM,CS,E,MS

Yokogawa-Hewlett-Packard Ltd.  
 Chuo Bldg., 4th Floor  
 5-4-20 Nishinakajima, 5-chome  
 Yodogawa-ku, Osaka-shi  
**OSAKA**, 532  
 Tel: (06) 304-6021  
 Telex: YHPOSA 523-3624  
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Yokogawa-Hewlett-Packard Ltd.  
 29-21 Takaido-Higashi 3-chome  
 Suginami-ku **TOKYO** 168  
 Tel: (03) 331-6111  
 Telex: 232-2024 YHPTOK  
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**Mouasher Cousins Company**  
 P.O. Box 1387  
**AMMAN**  
 Tel: 24907, 39907  
 Telex: 21456 SABCO JO  
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**Samsung Electronics**  
 4759 Shinkil, 6 Dong  
 Youngdeungpo-Ku,  
**SEOUL**  
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 Telex: SAMSAN 27364  
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 P.O. Box 270 Safat  
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 Tel: 42-2846, 42-3801  
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Hewlett-Packard Belgium S.A./N.V.  
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 Woluwedal  
 B-1200 **BRUSSELS**  
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 Telex: 23-494 paloben bru  
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 Bangunan Angkasa Raya  
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**KUALA LUMPUR**  
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 Telex: MA31011  
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 Lot 319, Satok Rd.  
 P.O. Box 1917  
**KUCHING, SARAWAK**  
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 Telex: MA 70904 Promal  
 Cable: Proteleng  
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Hewlett-Packard Mexicana, S.A. de  
 C.V.  
 Avenida Periferico Sur No. 6501  
 Tepepan, Xochimilco  
**MEXICO CITY 23, D.F.**  
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 Telex: 017-74-507  
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 Hewlett-Packard Mexicana, S.A. de  
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 Rio Volga 600  
 Colonia del Valle  
**MONTERREY, N.L.**  
 Tel: 78-42-93, 78-42-40, 78-42-41  
 Telex: 038-410  
 CS

**MOROCCO**

**Dolbeau**  
 81 rue Karatchi  
**CASABLANCA**  
 Tel: 3041-82, 3068-38  
 Telex: 23051, 22822  
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 Gerez  
 2 rue d'Agadir  
 Boite Postale 156  
**CASABLANCA**  
 Tel: 272093, 272095  
 Telex: 23 739  
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**NETHERLANDS**

Hewlett-Packard Nederland B.V.  
 Van Heuven Goedhartlaan 121  
 NL 1181KK **AMSTELVEEN**  
 P.O. Box 667  
 NL 1080 AR **AMSTELVEEN**  
 Tel: (20) 47-20-21  
 Telex: 13 216  
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 Hewlett-Packard Nederland B.V.  
 Bongerd 2  
 NL 2906VK **CAPPELLE**, A/D IJssel  
 P.O. Box 41  
 NL 2900 AA **CAPPELLE**, IJssel  
 Tel: (10) 51-64-44  
 Telex: 21261 HEPAC NL  
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**NEW ZEALAND**

Hewlett-Packard (N.Z.) Ltd.  
 169 Manukau Road  
 P.O. Box 26-189  
 Epsom, **AUCKLAND**  
 Tel: 68-7159  
 Cable: HEWPACK Auckland  
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Hewlett-Packard (N.Z.) Ltd.  
 4-12 Cruickshank Street  
 P.O. Box 9443  
 Kilbirnie, **WELLINGTON 3**  
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 Ltd.  
 Eden House, 44 Khyber Pass Road  
 P.O. Box 9682  
 Newmarket, **AUCKLAND**  
 Tel: 794-091  
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 Northrop Instruments & Systems  
 Ltd.  
 Terrace House, 4 Oxford Terrace  
 P.O. Box 8388  
**CHRISTCHURCH**  
 Tel: 64-165  
 A,M  
 Northrop Instruments & Systems  
 Ltd.  
 Sturdee House  
 85-87 Ghuznee Street  
 P.O. Box 2406  
**WELLINGTON**  
 Tel: 850-091  
 Telex: NZ 3380  
 A,M

**NIGERIA**

**The Electronics Instrumentations**  
 Ltd.  
 N6B/S70 Oyo Road  
 Oluseun House  
 P.M.B. 5402  
**IBADAN**  
 Tel: 461577  
 Telex: 31231 TEIL NG  
 A,E,M,P  
 The Electronics Instrumentations  
 Ltd.  
 144 Agege Motor Road, Mushin  
 P.O. Box 6645  
**Mushin, LAGOS**  
 A,E,M,P

**NORTHERN IRELAND**

**Cardiac Services Company**  
 95A Finaghy Road South  
**BELFAST BT 10 OBY**  
 Tel: (0232) 625-566  
 Telex: 747626  
 M

**NORWAY**

Hewlett-Packard Norge A/S  
 Folke Bernadottesvei 50  
 P.O. Box 3558  
 N-5033 **FYLLINGSDALEN** (BERGEN)  
 Tel: (05) 16-55-40  
 Telex: 16621 hpnas n  
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 Hewlett-Packard Norge A/S  
 Oesterlands 18  
 P.O. Box 34  
 N-1345 **OESTERAAS**  
 Tel: (02) 17-11-80  
 Telex: 16621 hpnas n  
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**OMAN**

**Khimji Ramdas**  
 P.O. Box 19  
**MUSCAT**  
 Tel: 72-22-17, 72-22-25  
 Telex: 3289 BROKER MB MUSCAT  
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**PAKISTAN**

**Mushko & Company Ltd.**  
 10, Bazar Road  
 Sector G-6/4  
**ISLAMABAD**  
 Tel: 28624  
 Cable: FEMUS Rawalpindi  
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 Mushko & Company Ltd.  
 Oosman Chambers  
 Abdullah Haroon Road  
**KARACHI 0302**  
 Tel: 511027, 512927  
 Telex: 2894 MUSHKO PW  
 Cable: COOPERATOR Karachi  
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**PANAMA**

**Electrónico Balboa, S.A.**  
 Apartado 4929  
 Panama 5  
 Calle Samuel Lewis  
 Edificio "Alfa" No. 2  
**CIUDAD DE PANAMA**  
 Tel: 64-2700  
 Telex: 3480380  
 Cable: ELECTRON Panama  
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 Foto Internacional, S.A.  
 P.O. Box 2068  
 Free Zone of Colon  
**COLON 3**  
 Tel: 45-2333  
 Telex: 3485126  
 Cable: IMPORT COLON/Panama  
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**PERU**

**Compañía Electro Médica S.A.**  
 Los Flamencos 145, San Isidro  
 Casilla 1030  
**LIMA 1**  
 Tel: 41-4325  
 Telex: Pub. Booth 25424 SISIDRO  
 Cable: ELMED Lima  
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**PHILIPPINES**

**The Online Advanced Systems**  
 Corporation  
 Rico House, Amorsolo Cor. Herrera  
 Street  
 Legaspi Village, Makati  
 P.O. Box 1510  
**Metro MANILA**  
 Tel: 85-35-81, 85-34-91, 85-32-21  
 Telex: 3274 ONLINE  
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**Electronic Specialists and**  
 Proponents Inc.  
 690-B Epifanio de los Santos  
 Avenue  
 Cubao, **QUEZON CITY**  
 P.O. Box 2649 Manila  
 Tel: 98-96-81, 98-96-82, 98-96-83  
 Telex: 742-40287  
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**POLAND**

**Buro Informacji Technicznej**  
 Hewlett-Packard  
 Ul Stawki 2, 6P  
**PL00-950 WARSZAWA**  
 Tel: 39-59-62, 39-67-43  
 Telex: 812453 hepa pl



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Arranged alphabetically by country

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*Telectra-Empresa Técnica de Equipamentos Eléctricos S.a.r.l.*  
Rua Rodrigo da Fonseca 103  
P.O. Box 2531

### P-LISBON 1

Tel: (19) 68-60-72  
Telex: 12598  
A,C,E,P

### Mundinter

*Intercambio Mundial de Comércio S.a.r.l.*

P.O. Box 2761

Avenida Antonio Augusto de Aguiar

138

### P-LISBON

Tel: (19) 53-21-31, 53-21-37

Telex: 16691 munter p

M

## PUERTO RICO

Hewlett-Packard Puerto Rico  
P.O. Box 4407

CAROLINA, Puerto Rico 00630  
Calle 272 Edificio 203

Urb. Country Club

RIO PIEDRAS, Puerto Rico 00924

Tel: (809) 762-7255

Telex: 345 0514

A,CP

## QATAR

*Nasser Trading & Contracting*  
P.O. Box 1563

### DOHA

Tel: 22170

Telex: 4439 NASSER

M

### Scitecharabia

P.O. Box 2750

### DOHA

Tel: 329515

Telex: 4806 CMPARB

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## ROMANIA

*Hewlett-Packard Reprezentanta*  
Boulevard Nicolae Balcescu 16

### BUCURESTI

Tel: 130725

Telex: 10440

## SAUDI ARABIA

*Modern Electronic Establishment*  
P.O. Box 193

### AL-KHOBAR

Tel: 44-678, 44-813

Telex: 670136

Cable: ELECTA AL-KHOBAR

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*Modern Electronic Establishment*  
P.O. Box 1228, Baghdadiyah Street

### JEDDAH

Tel: 27-798

Telex: 401035

Cable: ELECTA JEDDAH

C,E,M,P

*Modern Electronic Establishment*  
P.O. Box 2728

### RIYADH

Tel: 62-596, 66-232

Telex: 202049

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## SCOTLAND

Hewlett-Packard Ltd.

Royal Bank Buildings

Swan Street

BRECHIN, Angus, Scotland

Tel: 3101, 3102

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Hewlett-Packard Ltd.

## SOUTH QUEENSFERRY

West Lothian, EH30 9TG

GB-Scotland

Tel: (031) 3311000

Telex: 72682

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## SINGAPORE

Hewlett-Packard Singapore (Pty.)

Ltd.

P.O. Box 58 Alexandra Post Office

SINGAPORE, 9115

6th Floor, Inchcape House

450-452 Alexandra Road

SINGAPORE 0511

Tel: 631788

Telex: HPSGSO RS 34209

Cable: HEWPACK, Singapore

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Ltd.

P.O. Box 120

Howard Place

Pine Park Center, Forest Drive,

Pinelands

CAPE PROVINCE 7450

Tel: 53-7955, 53-7956, 53-7957

Telex: 57-0006

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Hewlett-Packard South Africa (Pty.)

Ltd.

P.O. Box 37066

Overport

DURBAN 4067

Tel: 28-4178, 28-4179, 28-4110

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Hewlett-Packard South Africa (Pty.)

Ltd.

P.O. Box 33345

Glenstantia 0010 TRANSVAAL

1st Floor East

Constantia Park Ridge Shopping

Centre

Constantia Park

PRETORIA Tel: 98-1126 or 98-1220

Telex: 32163

C,E

Hewlett-Packard South Africa (Pty.)

Ltd.

Daphny Street

Private Bag Wendywood

SANDTON 2144

Tel: 802-5111, 802-5125

Telex: 89-84782

Cable: HEWPACK Johannesburg

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## SPAIN

Hewlett-Packard Española S.A.

c/Entenza, 321

E-BARCELONA 29

Tel: (3) 322-24-51, 321-73-54

Telex: 52603 hpbee

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Hewlett-Packard Española S.A.

c/San Vicente S/N

Edificio Albia II, 7 B

E-BILBAO 1

Tel: (944) 423-8306, 423-8206

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Hewlett-Packard Española S.A.

Calle Jerez 3

E-MADRID 16

Tel: 458-2600

Telex: 23515 hpe

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Hewlett-Packard Española S.A.

Colonia Mirasierra

Edificio Juban

c/o Costa Brava 13, 2.

E-MADRID 34

Tel: 734-8061, 734-1162

CM,CP

Hewlett-Packard Española S.A.

Av Ramón y Cajal 1-9

Edificio Sevilla 1,

E-SEVILLA 5

Tel: 64-44-54, 64-44-58

Telex: 72933

A,CM,CS,MS,P

Hewlett-Packard Española S.A.

C/Ramon Gorrillo, 1 (Entlo.3)

E-VALENCIA 10

Tel: 361-1354, 361-1358

CM,CS,P

## SWEDEN

Hewlett-Packard Sverige AB

Enighetsvägen 3, Fack

P.O. Box 20502

S-16120 BROMMA

Tel: (08) 730-0550

Telex: (854) 10721 MESSAGES

Cable: MEASUREMENTS

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Hewlett-Packard Sverige AB

Sunnanvagen 14K

S-22226 LUND

Tel: (46) 13-69-79

Telex: (854) 10721 (via BROMMA

office)

CM,CS

Hewlett-Packard Sverige AB

Vastra Vintergatan 9

S-70344 ÖREBRO

Tel: (19) 10-48-80

Telex: (854) 10721 (via BROMMA

office)

CM,CS

Hewlett-Packard Sverige AB

Frötallingsgatan 30

S-42132 VÄSTRA-FRÖLUNDA

Tel: (031) 49-09-50

Telex: (854) 10721 (via BROMMA

office)

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## SWITZERLAND

Hewlett-Packard (Schweiz) AG

Clarastrasse 12

CH-4058 BASLE

Tel: (61) 33-59-20

A,CM

Hewlett-Packard (Schweiz) AG

47 Avenue Blanc

CH-1202 GENEVA

Tel: (022) 32-30-05, 32-48-00

CM,CP

Hewlett-Packard (Schweiz) AG

29 Chemin Château Bloc

CH-1219 LE LIGNON-Geneva

Tel: (022) 96-03-22

Telex: 27333 hpag ch

Cable: HEWPACKAG Geneva

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Hewlett-Packard (Schweiz) AG

Zürcherstrasse 20

Allmend 2

CH-8967 WIDEN

Tel: (57) 50-111

Telex: 59933 hpag ch

Cable: HPAG CH

A,CM,CP,E,MS,P

## SYRIA

*General Electronic Inc.*

Nuri Basha-Ahmal Ebn Kays Street

P.O. Box 5781

### DAMASCUS

Tel: 33-24-87

Telex: 11215 ITIKAL

Cable: ELECTROBOR DAMASCUS

E

Sawah & Co.

Place Azmé

Boite Postale 2308

### DAMASCUS

Tel: 16-367, 19-697, 14-268

Telex: 11304 SATACO SY

Cable: SAWAH, DAMASCUS

M

## TAIWAN

Hewlett-Packard Far East Ltd.

Kaohsiung Branch

68-2, Chung Cheng 3rd Road

Shin Shin, Chu

### KAOSHIUNG

Tel: 24-2318, 26-3253

CS,E,MS,P

Hewlett-Packard Far East Ltd.

Taiwan Branch

5th Floor

205 Tun Hwa North Road

### TAIPEI

Tel: (02) 751-0404

Cable: HEWPACK Taipei

A,CP,E,MS,P

Hewlett-Packard Far East Ltd.

Taichung Branch

#33, Cheng Yih Street

10th Floor, Room 5

### TAICHUNG

Tel: 289274

Ing Lih Trading Co.

3rd Floor 18, Po-la Road

### TAIPEI

Tel:

Telex:

Cable: INGLIH TAIPEI

A

## THAILAND

UNIMESA Co. Ltd.

Elcom Research Building

2538 Sukhumvit Ave.

Bangchak, BANGKOK

Tel: 393-2387, 393-0338

Telex: TH81160, 82938, 81038

Cable: UNIMESA Bangkok

A,C,E,M

Bangkok Business Equipment Ltd.

5/5-6 Dejo Road

### BANGKOK

Tel: 234-8670, 234-8671,

234-8672

Cable: BUSIQUIPT Bangkok

P

## TRINIDAD & TOBAGO

Caribbean Telecoms Ltd.

P.O. Box 732

50/A Jerningham Avenue

### PORT-OF-SPAIN

Tel: 624-4213, 624-4214

A,CM,E,M,P

## TUNISIA

*Tunisie Electronique*

31 Avenue de la Liberté

### TUNIS

Tel: 280-144

E,P

Corema

1 ter. Av. de Carthage

### TUNIS



## UNITED STATES (Cont.)

**California**

Hewlett-Packard Co.  
7621 Canoga Avenue  
CANOGA PARK, CA 91304  
Tel: (213) 702-8300  
A,CM,CP,E,P

Hewlett-Packard Co.  
1579 W. Shaw Avenue  
FRESNO, CA 93771  
Tel: (209) 224-0582  
CM,MS

Hewlett-Packard Co.  
1430 East Orangethorpe  
FULLERTON, CA 92631  
Tel: (714) 870-1000  
CM,CP,E,MP

Hewlett-Packard Co.  
5400 W. Rosecrans Boulevard  
LAWNDALE, CA 90260  
P.O. Box 92105  
LOS ANGELES, CA 90009  
Tel: (213) 970-7500  
CM,CP,MP

Hewlett-Packard Co.  
3939 Lankershim Blvd.  
NORTH HOLLYWOOD, CA 91604  
Tel: (213) 877-1282  
Regional Headquarters

Hewlett-Packard Co.  
3200 Hillview Avenue  
PALO ALTO, CA 94304  
Tel: (415) 857-8000  
CM,CP,E

Hewlett-Packard Co.  
646 W. North Market Boulevard  
SACRAMENTO, CA 95834  
Tel: (916) 929-7222  
A\*,CM,CP,E,MS

Hewlett-Packard Co.  
9606 Aero Drive  
P.O. Box 23333  
SAN DIEGO, CA 92123  
Tel: (714) 279-3200  
CM,CP,E,MP

Hewlett-Packard Co.  
3003 Scott Boulevard  
SANTA CLARA, CA 95050  
Tel: (408) 988-7000  
A,CM,CP,E,MP

Hewlett-Packard Co.  
454 Carlton Court  
SO. SAN FRANCISCO, CA 94080  
Tel: (415) 877-0772  
CM,CP

**Colorado**

Hewlett-Packard Co.  
24 Inverness Place, East  
ENGLEWOOD, CO 80112  
Tel: (303) 771-3455  
A,CM,CP,E,MS

**Connecticut**

Hewlett-Packard Co.  
47 Barnes Industrial Road South  
P.O. Box 5007  
WALLINGFORD, CT 06492  
Tel: (203) 265-7801  
A,CM,CP,E,MS

**Florida**

Hewlett-Packard Co.  
P.O. Box 24210  
2727 N.W. 62nd Street  
FORT LAUDERDALE, FL 33309  
Tel: (305) 973-2600  
CM,CP,E,MP

Hewlett-Packard Co.  
4080 Woodcock Drive, #132  
Brownell Building  
JACKSONVILLE, FL 32207  
Tel: (904) 398-0663  
CM,C\*,E\*,MS\*\*

Hewlett-Packard Co.  
P.O. Box 13910  
6177 Lake Ellenor Drive  
ORLANDO, FL 32809  
Tel: (305) 859-2900  
A,CM,CP,E,MS

Hewlett-Packard Co.  
6425 N. Pensacola Blvd.  
Suite 4, Building 1  
PENSACOLA, FL 32575  
Tel: (904) 476-8422  
A,CM,MS

Hewlett-Packard Co.  
110 South Hoover, Suite 120  
Vanguard Bldg.  
TAMPA, FL 33609  
Tel: (813) 872-0900  
A\*,CM,CS,E\*,M\*

**Georgia**

Hewlett-Packard Co.  
P.O. Box 105005  
2000 South Park Place  
ATLANTA, GA 30339  
Tel: (404) 955-1500  
Telex: 810-766-4890  
A,CM,CP,E,MP

Hewlett-Packard Co.  
Executive Park Suite 306  
P.O. Box 816  
AUGUSTA, GA 30907  
Tel: (404) 736-0592  
CM,MS

Hewlett-Packard Co.  
P.O. Box 2103  
1172 N. Davis Drive  
WARNER ROBINS, GA 31098  
Tel: (912) 922-0449  
CM,E

**Hawaii**

Hewlett-Packard Co.  
Kawaiahao Plaza, Suite 190  
567 South King Street  
HONOLULU, HI 96813  
Tel: (808) 526-1555  
A,CM,CS,E,MS

**Idaho**

Hewlett-Packard Co.  
11311 Chinden Boulevard  
BOISE, ID 83707  
Tel: (208) 376-6000  
CM,CS,M\*

**Illinois**

Hewlett-Packard Co.  
211 Prospect Road  
BLOOMINGTON, IL 61701  
Tel: (309) 663-0383  
CM,CS,MS\*\*

Hewlett-Packard Co.  
1100 31st Street  
DOWNERS GROVE, IL 60515  
Tel: (312) 960-5760  
CM,CP

Hewlett-Packard Co.  
5201 Tollview Drive  
ROLLING MEADOWS, IL 60008  
Tel: (312) 255-9800  
A,CM,CP,E,MP

**Indiana**

Hewlett-Packard Co.  
P.O. Box 50807  
7301 No. Shadeland Avenue  
INDIANAPOLIS, IN 46250  
Tel: (317) 842-1000  
A,CM,CS,E,MS

**Iowa**

Hewlett-Packard Co.  
2415 Heinz Road  
IOWA CITY, IA 52240  
Tel: (319) 351-1020  
CM,CS,E\*,MS

**Kansas**

Hewlett-Packard Co.  
1644 S. Rock  
WICHITA, KA 67207  
Tel: (316) 265-5200  
CM,CS

**Kentucky**

Hewlett-Packard Co.  
10170 Linn Station Road  
Suite 525  
LOUISVILLE, KY 40223  
Tel: (502) 426-0100  
A,CM,CS,MS

**Louisiana**

Hewlett-Packard Co.  
P.O. Box 1449  
3229 Williams Boulevard  
KENNER, LA 70062  
Tel: (504) 443-6201  
A,CM,CS,E,MS

**Maryland**

Hewlett-Packard Co.  
7121 Standard Drive  
HANOVER, MD 21076  
Tel: (301) 796-7700  
A,CM,CP,E,MS

Hewlett-Packard Co.  
2 Choke Cherry Road  
ROCKVILLE, MD 20850  
Tel: (301) 948-6370  
Telex: 710-828-9685  
A,CM,CP,E,MP

**Massachusetts**

Hewlett-Packard Co.  
32 Hartwell Avenue  
LEXINGTON, MA 02173  
Tel: (617) 861-8960  
A,CM,CP,E,MP

**Michigan**

Hewlett-Packard Co.  
23855 Research Drive  
FARMINGTON HILLS, MI 48024  
Tel: (313) 476-6400  
A,CM,CP,E,MP

Hewlett-Packard Co.  
4326 Cascade Road S.E.  
GRAND RAPIDS, MI 49506  
Tel: (616) 957-1970  
CM,CS,MS

**Minnesota**

Hewlett-Packard Co.  
2025 W. Larpenteur Ave.  
ST. PAUL, MN 55113  
Tel: (612) 644-1100  
A,CM,CP,E,MP

**Mississippi**

Hewlett-Packard Co.  
P.O. Box 5028  
322 N. Mart Plaza  
JACKSON, MS 39216  
Tel: (601) 982-9363  
CM,MS

**Missouri**

Hewlett-Packard Co.  
11131 Colorado Avenue  
KANSAS CITY, MO 64137  
Tel: (816) 763-8000  
Telex: 910-771-2087  
A,CM,CS,E,MS

Hewlett-Packard Co.  
1024 Executive Parkway  
ST. LOUIS, MO 63141  
Tel: (314) 878-0200  
A,CM,CP,E,MP

**Nebraska**

Hewlett-Packard  
7101 Mercy Road  
Suite 101, IBX Building  
OMAHA, NE 68106  
Tel: (402) 392-0948  
CM,MS

**Nevada**

Hewlett-Packard Co.  
Suite D-130  
5030 Paradise Blvd.  
LAS VEGAS, NV 89119  
Tel: (702) 736-6610  
CM,MS\*\*

**New Jersey**

Hewlett-Packard Co.  
Crystal Brook Professional Building  
Route 35  
EATONTOWN, NJ 07724  
Tel: (201) 542-1384  
A\*,CM,C\*,E\*,P\*

Hewlett-Packard Co.  
W120 Century Road  
PARAMUS, NJ 07652  
Tel: (201) 265-5000  
A,CM,CP,E,MP

Hewlett-Packard Co.  
60 New England Avenue West  
PISCATAWAY, NJ 08854  
Tel: (201) 981-1199  
A,CM,CP,E

**New Mexico**

Hewlett-Packard Co.  
P.O. Box 11634  
11300 Lomas Blvd., N.E.  
ALBUQUERQUE, NM 87123  
Tel: (505) 292-1330  
Telex: 910-989-1185  
CM,CP,E,MS

**New York**

Hewlett-Packard Co.  
5 Computer Drive South  
ALBANY, NY 12205  
Tel: (518) 458-1550  
Telex: 710-444-4691  
A,CM,CS,E,MS

Hewlett-Packard Co.

9600 Main Street  
CLARENCE, NY 14031  
Tel: (716) 759-8621  
Telex: 710-523-1893

Hewlett-Packard Co.  
200 Cross Keys Office  
FAIRPORT, NY 14450  
Tel: (716) 223-9950  
Telex: 510-253-0092  
CM,CP,E,MS

Hewlett-Packard Co.  
No. 1 Pennsylvania Plaza  
55th Floor  
34th Street & 8th Avenue  
NEW YORK, NY 10119  
Tel: (212) 971-0800  
CM,CP,E\*,M\*

Hewlett-Packard Co.  
5858 East Molloy Road  
SYRACUSE NY 13211  
Tel: (315) 455-2486  
A,CM,CS,E,MS

Hewlett-Packard Co.  
3 Crossways Park West  
WOODBURY, NY 11797  
Tel: (516) 921-0300  
Telex: 510-221-2183  
A,CM,CP,E,MS

**North Carolina**

Hewlett-Packard Co.  
P.O. Box 15579  
2905 Guess Road (27705)  
DURHAM, NC 27704  
Tel: (919) 471-8466  
C,M

Hewlett-Packard Co.  
5605 Roanne Way  
GREENSBORO, NC 27409  
Tel: (919) 852-1800  
A,CM,CP,E,MS

**Ohio**

Hewlett-Packard Co.  
9920 Carver Road  
CINCINNATI, OH 45242  
Tel: (513) 891-9870  
CM,CP,MS

Hewlett-Packard Co.  
16500 Sprague Road  
CLEVELAND, OH 44130  
Tel: (216) 243-7300  
Telex: 810-423-9430  
A,CM,CP,E,MS

Hewlett-Packard Co.  
962 Crupper Ave.  
COLUMBUS, OH 43229  
Tel: (614) 436-1041  
CM,CP,E\*

Hewlett-Packard Co.  
330 Progress Rd.  
DAYTON, OH 45449  
Tel: (513) 859-8202  
A,CM,CP,E\*,MS

**Oklahoma**

Hewlett-Packard Co.  
P.O. Box 366  
1503 W. Gore Blvd., Suite #2  
LAWTON, OK 73502  
Tel: (405) 248-4248  
C

Hewlett-Packard Co.  
P.O. Box 32008  
304 N. Meridan Avenue, Suite A  
OKLAHOMA CITY, OK 73107  
Tel: (405) 946-9499  
A\*,CM,CP,E\*,MS

Hewlett-Packard Co.  
Suite 121  
9920 E. 42nd Street  
TULSA, OK 74145  
Tel: (918) 665-3300  
A\*\*CM,CS,M\*

**Oregon**

Hewlett-Packard Co.  
1500 Valley River Drive, Suite 330  
EUGENE, OR 97401  
Tel: (503) 683-8075  
C

Hewlett-Packard Co.  
9255 S. W. Pioneer Court  
WILSONVILLE, OR 97070  
Tel: (503) 682-8000  
A,CM,CP,E\*,MS

**Pennsylvania**

Hewlett-Packard Co.  
1021 8th Avenue  
King of Prussia Industrial Park  
KING OF PRUSSIA, PA 19406  
Tel: (215) 265-7000  
Telex: 510-660-2670  
A,CM,CP,E,MP

Hewlett-Packard Co.  
111 Zeta Drive  
PITTSBURGH, PA 15238  
Tel: (412) 782-0400  
A,CM,CP,E,MP

**South Carolina**

Hewlett-Packard Co.  
P.O. Box 6442  
6941-0 N. Trenholm Road  
COLUMBIA, SC 29260  
Tel: (803) 782-6493  
CM,CS,E,MS



# SALES & SUPPORT OFFICES

Arranged alphabetically by country

## UNITED STATES (Cont.)

### South Carolina (Cont.)

Hewlett-Packard Co.  
814 Wade Hampton Blvd.  
Suite 10  
GREENVILLE, SC 29609  
Tel: (803) 232-0917  
C

### Tennessee

Hewlett-Packard Co.  
P.O. Box 22490  
224 Peters Road  
Suite 102  
KNOXVILLE, TN 37922  
Tel: (615) 691-2371  
A\*,CM,MS  
Hewlett-Packard Co.  
3070 Directors Row  
MEMPHIS, TN 38131  
Tel: (901) 346-8370  
A,CM,CS,MS  
Hewlett-Packard Co.  
Suite 103  
478 Craighead Street  
NASHVILLE, TN 37204  
Tel: (615) 383-9136  
CM,MS\*\*

### Texas

Hewlett-Packard Co.  
Suite 310W  
7800 Shoal Creek Blvd.  
AUSTIN, TX 78757  
Tel: (512) 459-3143  
CM,E  
Hewlett-Packard Co.  
Suite C-110  
4171 North Mesa  
EL PASO, TX 79902  
Tel: (915) 533-3555  
CM,CS,E\*,MS\*\*  
Hewlett-Packard Co.  
5020 Mark IV Parkway  
FORT WORTH, TX 76106  
Tel: (817) 625-6361  
CM,C\*  
Hewlett-Packard Co.  
P.O. Box 42816  
10535 Harwin Street  
HOUSTON, TX 77036  
Tel: (713) 776-6400  
A,CM,CP,E,MP  
Hewlett-Packard Co.  
3309 67th Street  
Suite 24  
LUBBOCK, TX 79413  
Tel: (806) 799-4472  
M  
Hewlett-Packard Co.  
P.O. Box 1270  
930 E. Campbell Rd.  
RICHARDSON, TX 75081  
Tel: (214) 231-6101  
A,CM,CP,E,MP  
Hewlett-Packard Co.  
205 Billy Mitchell Road  
SAN ANTONIO, TX 78226  
Tel: (512) 434-8241  
CM,CS,E,MS  
**Utah**  
Hewlett-Packard Co.  
3530 W. 2100 South Street  
SALT LAKE CITY, UT 84119  
Tel: (801) 974-1700  
A,CM,CP,E,MS  
**Virginia**  
Hewlett-Packard Co.  
P.O. Box 9669  
2914 Hungary Spring Road  
RICHMOND, VA 23228  
Tel: (804) 285-3431  
A,CM,CP,E,MS

Hewlett-Packard Co.  
P.O. Box 4786  
3110 Peters Creek Road, N.W.  
ROANOKE, VA 24015  
Tel: (703) 563-2205  
CM,CS,E\*\*

Hewlett-Packard Co.  
P.O. Box 12778  
5700 Thurston Avenue  
Suite 111  
VIRGINIA BEACH, VA 23455  
Tel: (804) 460-2471  
CM,CS,MS

### Washington

Hewlett-Packard Co.  
15815 S.E. 37th Street  
BELLEVUE, WA 98006  
Tel: (206) 643-4000  
A,CM,CP,E,MP  
Hewlett-Packard Co.  
Suite A  
708 North Argonne Road  
SPOKANE, WA 99206  
Tel: (509) 922-7000  
CM,CS

### West Virginia

Hewlett-Packard Co.  
4604 MacCorkle Ave., S.E.  
CHARLESTON, WV 25304  
Tel: (304) 925-0492  
A,CM,MS

### Wisconsin

Hewlett-Packard Co.  
150 S. Sunny Slope Road  
BROOKFIELD, WI 53005  
Tel: (414) 784-8800  
A,CM,CS,E\*,MP

### URUGUAY

Pablo Ferrando S.A.C. *e.l.*  
Avenida Italia 2877  
Casilla de Correo 370  
MONTEVIDEO  
Tel: 403102  
Telex: 901 Public Booth Para Pablo  
Ferrando 919520  
Cable: RADIUM Montevideo  
A,CM,E,M  
Guillermo Kraft del Uruguay S.A.  
Avda. Libertador Brig. Gral.  
Lavalleja 2083  
MONTEVIDEO  
Tel: 234588, 234808, 208830  
Telex: 6245 ACTOUR UY  
P

### U.S.S.R.

Hewlett-Packard Co.  
Representative Office  
Pokrovsky Blvd. 4/17 KV12  
MOSCOW 101000 Tel: 294-2024  
Telex: 7825 HEWPACK SU

### VENEZUELA

Hewlett-Packard de Venezuela C.A.  
Apartado 50933  
3A Transversal Los Ruices Norte  
Edificio Segre 2Y3  
CARACAS 1071  
Tel: 239-4133, 239-4777,  
239-4244  
Telex: 25146 HEWPACK  
Cable: HEWPACK Caracas  
A,CP,E,MS,P

### YUGOSLAVIA

Iskra-Commerce-Representation of  
Hewlett-Packard  
Sava Centar Delegacija 30  
Milentija Popovica 9  
11170 BEOGRAD  
Tel: 638-762  
Telex: 12042, 12322 YU SAV CEN

Iskra-Commerce-Representation of  
Hewlett-Packard  
Kopraska 46  
61000 LJUBLJANA  
Tel: 321674, 315879  
Telex:

### ZAMBIA

R. J. Tilbury (Zambia) Ltd.  
P.O. Box 2792  
LUSAKA  
Tel: 81243  
A,E,M,P

### ZIMBABWE

Field Technical Sales  
45 Kelvin Road, North  
P.B. 3458  
SALISBURY  
Tel:  
C,E,M,P

## FOR COUNTRIES AND AREAS NOT LISTED:

### CANADA

Ontario  
Hewlett-Packard (Canada) Ltd.  
6877 Goreway Drive  
MISSISSAUGA, Ontario L4V 1M8  
Tel: (416) 678-9430  
Telex: 610-492-4246

### EASTERN USA

Maryland  
Hewlett-Packard Co.  
4 Choke Cherry Road  
Rockville, MD 20850  
Tel: (301) 258-2000

### MIDWESTERN USA

Illinois  
Hewlett-Packard Co.  
5201 Tollview Drive  
ROLLING MEADOWS, IL 60008  
Tel: (312) 255-9800

### SOUTHERN USA

Georgia  
Hewlett-Packard Co.  
P.O. Box 105005  
450 Interstate N. Parkway  
ATLANTA, GA 30339  
Tel: (404) 955-1500

### WESTERN USA

California  
Hewlett-Packard Co.  
3939 Lankersim Blvd.  
LOS ANGELES, CA 91604  
Tel: (213) 877-1282

## EUROPEAN AREAS NOT LISTED, CONTACT

### SWITZERLAND

Hewlett-Packard S.A.  
7 Rue du Bois-du-Lan  
CH-1217 MEYRIN 2, Switzerland  
Tel: (022) 83-81-11  
Telex: 27835 hpse  
Cable: HEWPACKSA Geneve

## EAST EUROPEAN AREAS NOT LISTED, CONTACT

### AUSTRIA

Hewlett-Packard Ges.m.b.h.  
Wehlstrasse 29  
P.O. Box 7  
A-1205 VIENNA  
Tel: (222) 35-16-210  
Telex: 135823/135066

## MEDITERRANEAN AND MIDDLE EAST AREAS NOT LISTED, CONTACT

### GREECE

Hewlett-Packard S.A.  
Mediterranean & Middle East  
Operations  
35, Kolokotroni Street  
Platia Kefallariou  
GR-Kifissia, ATHENS, Greece  
Tel: 808-0359, 808-0429  
Telex: 21-6588  
Cable: HEWPACKSA Athens

## INTERNATIONAL AREAS NOT LISTED, CONTACT

### OTHER AREAS

Hewlett-Packard Co.  
Intercontinental Headquarters  
3495 Deer Creek Road  
PALO ALTO, CA 94304  
Tel: (415) 857-1501  
Telex: 034-8300  
Cable: HEWPACK



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PACKARD